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TRAINING DOCUMENT NO. 7

ANALYSIS OF STRUCTURAL AND NONSTRUCTURAL FLOOD CONTROL MEASURES USING COMPUTER PROGRAM HEC-5C

WILLIAM K. JOHNSON AND DARRYL W. DAVIS

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The authors illustrate how various flood control measures can be analyzed using the HEC-5C computer program. Basic principles in flood control planning and damage reduction are examined. Flood plain management measures include those designed to control hydrology and those designed to reduce susceptibility of property to damage. Hydrologic and economic relationships are examined and the affects of different types of flood control measures are presented. Of the eight control methods, levees or floodwalls were found to affect the stream's stage-discharge (CONTINUED)

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stage-damage, discharge-damage, and damage frequency relationships. Diversion and flood forecasting affected these relationships the least, but all the methods affected the damage frequency. The HEC-5C program was used to develop systems which maximize net economic benefits. Given an existing system and an array of flood control measures, the strategy proceeds by computing expected annual damages for the existing system; adding any one of the flood control measures and computing expected annual damages; then subtracting expected annual damages with or without the control measure. Finally, the best measure was chosen based upon its final net benefit yield. A final added strategy recomputed costs and benefits by removing one of the control measures to determine if a better net benefit figure would be yielded. The Fall River System of California was used to illustrate how the program functions.

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ANALYSIS OF STRUCTURAL AND NONSTRUCTURAL FLOOD CONTROL MEASURES USING COMPUTER PROGRAM HEC-5C

William K. Johnson and Darryl W. Davis

November 1975

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ANALYSIS OF STRUCTURAL AND NONSTRUCTURAL
FLOOD CONTROL MEASURES
USING COMPUTER PROGRAM HEC-5C

by William K. Johnson and Darryl W. Davis

INTRODUCTION

This training document is intended to illustrate how a variety of structural and nonstructural flood control measures can be analyzed using computer program HEC-5C, "Simulation of Flood Control and Conservation System." Originally developed in 1973 by Bill S. Eichert, the program has undergone several significant changes to make it a more useful tool in the formulation and assessment of flood control systems. A major addition was the development, by Darryl Davis and Harold Kubik, of an economic routine to compute average annual damages at specified damage centers within the system. This in turn leads to damages reduced or inundation reduction benefits. Its full computational capabilities are described in references 1 and 2.

This document is divided into three parts and illustrates how this model can be used in planning to formulate and assess alternative systems of both structural and nonstructural measures. The first part is a discussion of some basic principles of flood control planning; part II illustrates the application of many of the principles described in part I; the third part contains supportive computer output developed as part of the application in part II.

PART I

FLOOD CONTROL AND DAMAGE REDUCTION

A variety of flood plain management measures are available to reduce flood damage. Their primary purpose is to protect damageable property, both existing and future, and they do this in one of two ways. Either they are designed to control the hydrology, that is, the magnitude or frequency of flooding, or they are designed to reduce the susceptibility of property to damage. The tabulation below shows typical measures of each type (see also reference 5).

Flood Plain Management Measures

Those Designed to Control the Hydrology	Those Designed to Reduce the Susceptibility of Property to Damage
Reservoirs	Flood Proofing
Levee or Floodwall	Relocation
Channel Modification	Flood Warning
Diversion	
Flood Forecasting	

Measures designed to alter the hydrology, either locally or throughout a system, can alter various hydrologic relationships which exist at specific locations. Similarly, measures designed to modify the susceptibility of property to damage can, through the protection they provide, alter economic relationships which exist. Because both hydrologic and economic relationships are used to compute the magnitude of damage

caused by inundation, it is important to understand what these relationships are, and how they can be altered by the various measures.

Hydrologic and Economic Relationships

Stage-Discharge Relationship (Figure 1)

This is a basic hydraulic function which has many uses in water resources engineering. In river channels or flood plains it expresses, for a specific location, the fact that under most conditions, as the river stage increases, the river discharge increases.

Stage-Damage Relationship (Figure 3)

This is the economic counterpart to the stage-discharge function and represents, at a specific location, the magnitude of dollar damages which may occur in a river reach, at a given river stage. Usually the damages represent an aggregate of damages which occur some distance upstream and downstream from the specified location.

Discharge-Damage Relationship (Figure 4)

Stage is a common parameter to both the stage-discharge and stage-damage functions and as such may be used to develop a function relating discharge to damage.

Discharge-Frequency Relationship (Figure 2)

Using historic streamflow records, the exceedance frequency of various magnitudes of annual peak flow can be estimated using statistical techniques. Because exceedance frequency expresses the frequency with which certain events occur over time it is used for computing damages

on an average annual basis, and for determining the degree of protection and risk of various measures. It is developed for a specific location in the system.

Damage-Frequency Relationship (Figure 5)

The common parameter in both the discharge-damage and discharge-frequency relationships is river discharge. By selecting a range of discharges a function relating damages to exceedance frequency can be developed. The integration of this function, that is, determining the area beneath a graphical representation of the function, is the expected annual damages at that location. When various measures are considered in planning the reduction in damages is measured as the difference between the expected annual damages without the measures (existing conditions) and the expected annual damages with the flood control measures in place (modified conditions). Any changes which occur in the stage-discharge, stage-damage, or discharge-frequency relationships will be reflected in the damage-frequency function, and therefore in the magnitude of the expected damage reduction.

Generally, from a national viewpoint, the economic benefits of implementing flood control measures are the economic contributions which result from improving the net productivity of flood-prone land. This improvement may come about by reducing damages to the land under its present and anticipated future use, by allowing for more intensive use, and by attracting new uses. Detailed principles and procedures for computing these benefits are discussed in reference 4. The hydrologic and economic

relationships discussed previously are used to compute damage reduction which is the economic benefit resulting from preventing inundation. Throughout this document economic benefit refers to the damage reduction benefit.

Effects of Flood Control Measures

Reservoirs

The function of a flood control reservoir is to store flood waters during storm periods and release them during periods of lower flow. Because the flow of the stream upon which the reservoir is located is interrupted, the flood frequency at all locations downstream can be altered, that is, the magnitude of flow can be reduced for a given frequency of event. The magnitude of this flow reduction may be small or large depending upon the size of the reservoir, the magnitude and centering of the storm, and the location of the reservoir in relation to the downstream point. Upstream from the reservoir, the streamflow remains unaltered except for any backwater effect which may exist where the stream enters the reservoir pool. A discharge-exceedance frequency relationship at a point immediately downstream would be altered to reflect lower flows for a given exceedance frequency, or alternately for a given magnitude of flow the occurrence is less frequent. This is the direct hydrologic effect of controlling the flow. The economic effect is a reduction in expected annual flood damages brought about by a lessening of the expected magnitude and frequency of flooding.

Because reservoirs can be operated to make releases at desired times, locations and in desired amounts their effect can extend beyond immediate downstream points to other locations in the system. This influence, or system effect, can take many forms, for example,

Timing - the timing of flood peaks at a particular location can be affected with reservoir regulation. Peaks may be made to occur before, after or coincident depending upon operating criteria.

Location - Reservoirs in a system usually operate to reduce flooding at one or more locations. When one location is removed, by providing flood control through some other measure, for example, relocation, it allows the reservoir to operate more effectively for those locations remaining.

Magnitude - The magnitude of flow released from one reservoir in a system influences how much is released from the others and can therefore influence the flood storage remaining.

Levees and Floodwalls

Levees and floodwalls are designed to prevent flooding in areas adjacent to a river or flood plain. They provide a direct means of flood protection in that they can be located where needed and can act to confine flood waters to the channel up to the design discharge. In cases where the levee or floodwall prevents flood flows from occupying areas in the flood plain or channel that normally would be occupied, the river stage will be higher for a given flow. This is caused by a

reduction in cross-sectional area available to carry the flood flow. Downstream, higher flood peaks can occur because valuable flood plain storage was eliminated upstream increasing the concentration of runoff. So while levees and floodwalls have the local effect of increasing the height of the channel's sides and reducing flooding at that location, they can, at the same, have the system effect of increasing flooding downstream.

These changes can alter the hydrologic and economic relationships which exist at a given location by raising the stage-discharge function (assuming less cross-sectional area for a given flow) and by truncating the lower portion of the stage-damage function (assuming no damages will occur below the top of the levee or floodwall). If the reduction in flood plain storage is substantial this could alter the discharge-frequency function downstream, much in the way reducing the storage in a small unregulated reservoir would. The magnitude of these changes depends upon the specific circumstances.

Channel Modifications

Channel modifications are usually designed to increase the carrying capacity of a reach of river. This is often accomplished by increasing the cross-sectional flow area by enlarging the channel; decreasing surface roughness by clearing and snagging or lining the channel; and reducing the energy loss by straightening a channel reach. All of these actions are aimed at passing flows more efficiently, that is, the conveyance area is reduced and velocity increased, resulting in a lowering of river stage

for a given flow, and therefore altering the stage-discharge function. Downstream from the channel modification the magnitude of flow may be greater than without the modification, that is, the magnitude of flow may increase for a given exceedance frequency event. This occurs because the lowering of stage upstream causes less water to be stored in the channel, thus the attenuation effect is less, which again is analogous to the storage effect of reservoirs - less storage, less attenuation. Actual magnitudes of change depend upon the modification and length of river reach.

Diversion

A flow diversion is intended to take water out of the river during high stages and divert it away from the main channel. This has the immediate effect of reducing the amount of flow at all locations below the diversion either by decreasing the magnitude of flow or altering the timing in the case of return flow. At all points below the diversion, the discharge-frequency function will be altered - usually lowered - except where return flow coincides with peak flow in the main channel in which case the total channel flow could be higher than without the diversion. Therefore, two factors - magnitude of diversion and timing of return flow - can influence the manner in which the discharge frequency function is altered.

Flood Forecasting

Knowing in advance where and how much runoff will occur allows flood control measures, such as reservoirs and diversions, to be operated in a

manner such that flows are better controlled at critical damage centers, resulting hopefully, in lower damages than without forecasting. Knowing what flows to expect 12, 18, 24 hours in advance is better than taking them as they come. Knowledge of future flood events usually comes from a real-time flood forecasting network which includes rainfall and streamflow measuring equipment located throughout the basin with data fed into a central control which forecasts estimates of runoff and regulates reservoirs and diversions to minimize flood damage downstream. In terms of the hydrologic functions, the regulated discharge-frequency relationship downstream from reservoirs and diversions may be modified in that information which alters the operating decisions may result in different magnitudes of flow downstream. There would be no change in the stage-damage function.

Flood Proofing

As the name implies flood proofing is the protection of damageable property from flood waters. This usually means protecting individual structures and its contents. A variety of construction methods and materials are available to provide this protection, their use being determined by the type, location and susceptibility to damage of structure and contents. When protection is provided and a structure or group of structures are 'flood proofed' the relationship between stage and damages is modified since it is expected that less damage will occur for a given stage, up to the elevation of flood proofing. How this function will look will depend upon the type and extent of flood proofing. The hydrology will remain unchanged unless the flood proofing measures

result in a significant change to the flow area. In the context of system operation the existence of flood proofing lessens the need for control at that location, thus operation can be focused on other locations with higher damage potential.

Relocation

From the standpoint of strictly preventing flood damage, relocation can be completely effective if the structures are moved to a location free of potential flood damages. By removing damageable property from areas susceptible to floods there is no need for control or protection and no damage occurs. Unfortunately, this is not always a feasible alternative, however, it does play an important role as an alternative in some cases. The effect of relocation is to modify the stage-damage function by removing damageable property. If all damageable property is removed there would be no expected damages, if only a portion of the damages were removed the function would be modified accordingly.

Flood Warning

A reasonable advance warning can allow temporary measures to be implemented to protect or remove damageable property. For example, the evacuation of movable property or the raising or sandbagging of property which must remain. Flood warning is a combination of flood proofing and evacuation, and while it is not as dependable as the permanent measures it can help to reduce potential damages. Only the economic functions are altered as described in the sections on flood proofing and evacuation.

Summary

A summary of the direct effects of all the measures on each of the hydrologic and economic relationships are shown below. Each relationship is assumed to be at or downstream of the respective measure, for example, for a reservoir the direct effect is downstream, for a levee it is at the site.

Direct Effects of Flood Plain Management Measures on Hydrologic and Economic Relationships

Hydrologic and Economic Relationships (at or downstream from the measure for existing conditions) NC = No Change M = Modified

Measure	Stage-discharge 1/	Stage-damage 2/	Discharge-damage	Discharge frequency 3/	Damage Frequency
Reservoir	NC	NC	NC	M	M
Levee or Floodwall	M	M	M	NC	M
Channel Modification	M	NC	M	NC	M
Diversion	NC	NC	NC	M	M
Flood Forecasting	NC	NC	NC	M	M
Flood Proofing	NC	M	M	NC	M
Relocation	NC	M	M	NC	M
Flood Warning	NC	M	M	NC	M

1/ Where a reservoir or diversion significantly modifies the channel flow, deposition or erosion of channel material could alter the channel cross-section and thus the stage-discharge relationship. Also, removal or placement of damageable property in the floodplain could result in modifying the function.

2/ Along river reaches which have no floodplain regulation measures, such as a reservoir, could induce development onto the floodplain thus increasing the amount of damageable property and altering the stage-damage

function.

3/ Levees or channel modifications which reduce channel storage will probably not have an appreciable effect on the discharge-frequency relationships at their location, but could alter this relationship downstream.

SYSTEM FORMULATION

The major problem of system formulation is determining what combination of measures will produce the 'best' system. Three pieces of information can be useful in answering this question. First, information which provides an understanding of what each measure can do and under what conditions it is effective. This subject was discussed in the previous section. Second, a strategy for formulation - a rational, systematic approach which is likely to yield a 'better' system than if the approach were not followed. Third, a means to assess the overall performance of each system so that a 'best' system can be selected. Formulation strategies will be discussed below and the subject of system performance in the section which follows.

Formulation Strategies

At the plan formulation stage a variety of information is available both about the problem, the capability of measures to reduce or eliminate the problem, about public preferences, institutional guidance, and cost sharing capability. This is all important information and will influence not only the formulation of alternative plans, but their selection. How to utilize this information in a rational, systematic manner is the question to which formulation strategies hope to provide answers. A variety of approaches have been used in the past. These are identified and discussed in reference 3. The discussion which follows will utilize the mathematical model approach as a means to formulate alternatives to achieve the national economic development objective. Specifically, this means using simulation

model HEC-5C to develop systems which maximize net economic benefits, the traditional surrogate criterion for national economic development(6). Although there are other approaches which do not use mathematical models for formulation, models are still useful for assessing a system's performance and HEC-5C has the capability of analyzing a system's hydrologic and economic performance regardless of the strategy used to develop the system.

The principle of maximization of net economic benefits is applied by computing for each system or measure the flood damages and costs with and without the measure. The economic benefit derived from inundation reduction is the difference in damages with and without the measure. The difference between the benefits and costs is the net economic benefit. The objective of a strategy using this principle is to identify the system of measures which maximizes the net economic benefit. Two strategies useful for achieving this objective are discussed below:

First Added Strategy

Given an existing system and an array of flood control measures which are to be considered as possible additions to the existing system this strategy proceeds as follows:

- Compute the expected annual damages for the existing system.
- Add one of the flood control measures to the existing system and compute the expected annual damages.
- Subtract the expected annual damages with and without the flood control measure. (This difference represents the expected benefits of implementing the flood control measure.)

- Subtract the cost of the measure from the expected benefits, this difference is the net benefit.

- Remove the measure being considered from the existing system, add another measure to the existing system and repeat the computations. This procedure is repeated until all the measures being considered have been added individually to the existing system and their net benefits computed.

- That measure which provides the greatest net benefits (greatest positive value) is selected for inclusion in the existing system. This new system becomes the base system and the process is repeated by adding each measure one at a time, computing net benefits and selecting the next measure to be added. When no measures yield positive net benefits that is the system with maximum net benefits.

Table 1 contains information adapted from a recent study and illustrates this strategy. Flood control measures A-J are proposed for inclusion within the system. Measures A, C, and E have already been implemented. Stage 1 represents the 'first added' value of proposed measures. The incremental value (net benefits added) by measure F is the largest so it is selected for inclusion in the system. Stage 2 represents the 'first added' value of the measures with the base system now comprised of measures A, C, E, and F. Note that many of the values change because of system effects. Measure J is selected for addition to the system. The remainder of the table contains the analysis through to completion.

TABLE 1

FIRST ADDED FORMULATION STRATEGY

Measure	First Added Value ($1000 per year)[1]				Formulated System
	Stage 1	Stage 2	Stage 3	Stage 4	
A*	--	--	--	--	A
B	20	5	-2	-8	
C*	--	--	--	--	C
D	16	16	16**	--	D
E*	--	--	--	--	E
F	35**	--	--	--	F
G	-10	0	0	0	
H	6	-12	-12	-15	
I	-2	-2	-2	-2	
J	15	18**	--	--	J

[1] First added value is system net benefits with the measure added minus system net benefits without the measure added.

* Signifies existing system

**Signifies system addition

The name 'first added' is derived from the fact that each measure is considered as being the only or 'first' measure added to the existing or base system. The objective of this strategy is to identify that measure which will be the most help in reducing flood damages, add it to the existing system then seek out the next most effective measure and so on. Being able to identify the most effective measures is the advantage of this strategy. Unfortunately this is only a partial advantage. As measures are added the base system changes and a different base system may yield

different expected annual damages. For example, in Table 1 suppose that at stage 1 measure B was added instead of F, this would change the net benefits of all measures at stage 2 and perhaps D instead of J would yield the higher value. One might argue that it's improper to select B over F since F is a more effective measure. This would be correct if only one measure or a given level of damage reduction were sought, but as long as the sole criterion is maximization of net benefits it's the final system which is sought not the method by which one gets there. If by adding B before F in the strategy the final system included measures I and yielded more benefits then it would be a better system. The point is that one cannot be sure that by formulating a system using the 'first added' strategy the system with the maximum net benefits will result - there will always linger the feeling that there may be another combination of measures that may be better. In practice this problem may be more imaginary than real.

Last Added Strategy

As one might surmise from the name, this strategy considers all proposed measures added to the existing system and removes them individually one at a time, hence the name 'last added'. The procedure is as follows:

- Add to the existing system all proposed measures and compute the expected annual damages.
- Remove one of the measures from the system and compute the expected annual damages.
- Compute the difference in expected annual damages with and without the measure. This is the expected annual benefit of implementing the measure, i.e., adding it to the system.

- Subtract the cost of the measure from the expected benefits, this difference is the <u>net</u> benefits of adding the measure.

- Add the measure back into the system and remove another measure and repeat the computations. This procedure is repeated until all measures have been removed individually from the system and their <u>net</u> benefits computed.

- That measure which provides the least net benefits (greatest negative value) is removed permanently from the system. This new system becomes the base system and the process is repeated by subtracting each measure one at a time, computing net benefits, and selecting the next measure to be deleted. When all measures exhibit positive net benefits that is the system with the maximum net benefits by this strategy.

Table 2 contains information adapted from a recent study and illustrates the strategy. Flood control measures K through T are candidates for inclusion within a system. Measures L, P, and R have already been implemented. Stage 1 represents the 'last added' value of the measures. The incremental value (net benefits) lost by adding measure Q in the last position is the greatest (-30) so it is selected for deletion from the system. Stage 2 represents the 'last added' value of each measure with the base system now excluding component Q. Note that a number of the values have changed because of system effects. Measure K is selected for deletion. The remainder of the table contains the analysis through to completion.

TABLE 2

LAST ADDED FORMULATION STRATEGY

Measure	Last Added Value ($1000 per year)[1/] Stage 1	Stage 2	Stage 3	Stage 4	Formulated System
K	-20	-10**	--	--	
L*	--	--	--	--	L
M	10	0	-4**	--	
N	6	6	6	8	N
O	3	3	3	12	O
P*	--	--	--	--	P
Q	-30**	--	--	--	
R*	--	--	--	--	R
S	0	-6	12	10	S
T	-2	0	0	2	T

[1/]Last added value is system net benefits with the measure in the system minus system net benefits without the measure added.

* Signifies existing system.

**System measure that is dropped.

The 'last added' differs from the 'first added' strategy by the base system which is used to build upon and by its basic objective. The 'last added' begins with the existing system plus <u>all</u> proposed measures; the 'first added' begins with the existing system. Because each strategy will result in the formulation of different combinations of measures each strategy could arrive at a different system. However, as was mentioned in connection with the 'first added' strategy the realities of using other information and approaches in formulation, and the

gap between authorization and appropriation may minimize any significant differences. The 'last added' strategy does, however, introduce some complexities to the analysis where more than one measure at a location affects the same hydrologic or economic relationship. In this situation caution must be exercised to insure that the proper hydrologic and economic relationships are used. For example, a levee project has associated with it a particular stage-discharge relationship. Similarly, a channel modification project creates a unique stage-discharge relationship. When both are considered as alternative measures at the same location it would be necessary to develop a combined stage-discharge function when both are included in the 'last added' strategy. When one measure is removed the combined function would be replaced by the function for the measure remaining. A similar problem develops when considering flood proofing and relocation as alternative measures. If both are added to the system, as would be required for the 'last added' strategy, one may be redundant. For example, if all damageable property were removed there would be no need to flood proof. If, however, only a few structures were relocated and the remainder flood proofed both measures could be included provided a combined stage-damage function were developed. Combining relationships and avoiding redundant measures is not necessary when using the 'first added' strategy since each measure comes into the system one at a time.

While the objective of the 'first added' is to find the most effective measure to add, the objective of 'last added' is to find the least effective measure to delete. A reasonable strategy combining the two is

to apply the first and last added strategies through sufficient stages to identify those components that are obviously good, and to screen out those that are obviously inferior and zero in on the system to be selected by analyzing logical combinations of the remainder.

ASSESSMENT OF SYSTEM PERFORMANCE

Once alternative flood control systems have been formulated their performance should be assessed as the next step towards evaluation and selection. Assessment means an impartial, objective, factual display of the system performance. System performance refers to how a system functions. Whether this behavior is good or bad depends upon how it is supposed to function, and this in turn depends upon the purpose for which it was designed. The purpose of a flood control system is to reduce flood damages and its performance is measured by the extent to which this purpose is achieved and the manner by which it is achieved. Several measures of performance are described below and summarized on page 26.

Degree of Protection and Risk

Degree of protection is a measure of the hydrologic effectiveness of a system, expressed as the exceedance interval of the event that can be controlled to nondamaging flows. For example, 50-year protection means that, at a specific location, the peak flow of a flood with an exceedance interval of 50 years is not expected to exceed the nondamaging channel capacity at that location. Theoretically the flood peak and nondamaging

channel capacity are just equal; thus a flood with an exceedance interval of 51 years would exceed the nondamaging flow. It is important to recognize that degree of protection is associated with a specific location and discharge-frequency relationship. It is tied to location in the sense that it measures the protection, at a particular damage center, provided by measures either at that location or at other locations in the basin. It depends upon the discharge-frequency relationship because it is from this relationship that the exceedance interval is determined; and the frequency relationship itself is developed for a specific location.

Often the procedure for developing the modified function is to select hydrologic events with peak flows over the range covered by the unregulated frequency curve. The system's response to each event is then simulated and the resulting modified peak flow determined. Assuming the same exceedance frequency as the unregulated flow the regulated flow is then plotted to produce a modified frequency curve. Centering an event where a particular flood control measure will be effective in reducing peak flow will produce a different modified curve than if the centering were in a part of the basin where the measure could not be effective. Therefore, care must be exercised when selecting the events to be simulated so the relationship is as unbiased as possible. This is more a problem for large basins where the geographic differences between centerings can be large, than for small basins where there is less latitude for centering. Once a modified discharge-frequency relationship is developed the degree of protection is determined by finding the exceedance

interval for the nondamaging flow. The degree of protection for unregulated or existing conditions can be determined in the same manner using the appropriate frequency relationship.

Risk is defined as, "the probability that one or more events will exceed a given flood magnitude within a specified period of years." How does this differ from exceedance frequency and degree of protection? Both exceedance frequency and degree of protection, in their normal usage reflect the probability of an event being exceeded during any one year. Risk on the other hand usually refers to a probability not in any one year, but in some other specified time period. For example, to say a location has a 100-year level of protection is also to say that there is a 1% (1/100 year) chance that a flood will exceed that given level of protection during the next year. Or, put another way, there is a 1% risk. However, if instead of *any one year* we want to know the risk or percent chance of exceedance during the next 30 or 50 years, these values are 25% and 40%, respectively (see the data on next page). The graph on page 24 shows in graphical form the percent risk of one or more flood events being exceeded for a range of annual exceedance frequencies and periods of time. Risk is important as a hydrologic effectiveness criterion because it reflects the higher probability associated with a period longer than next year. And this is important because it conveys a more realistic picture of probable future conditions.

Estimated Risk*
Exceedance Frequency = 1% Annually

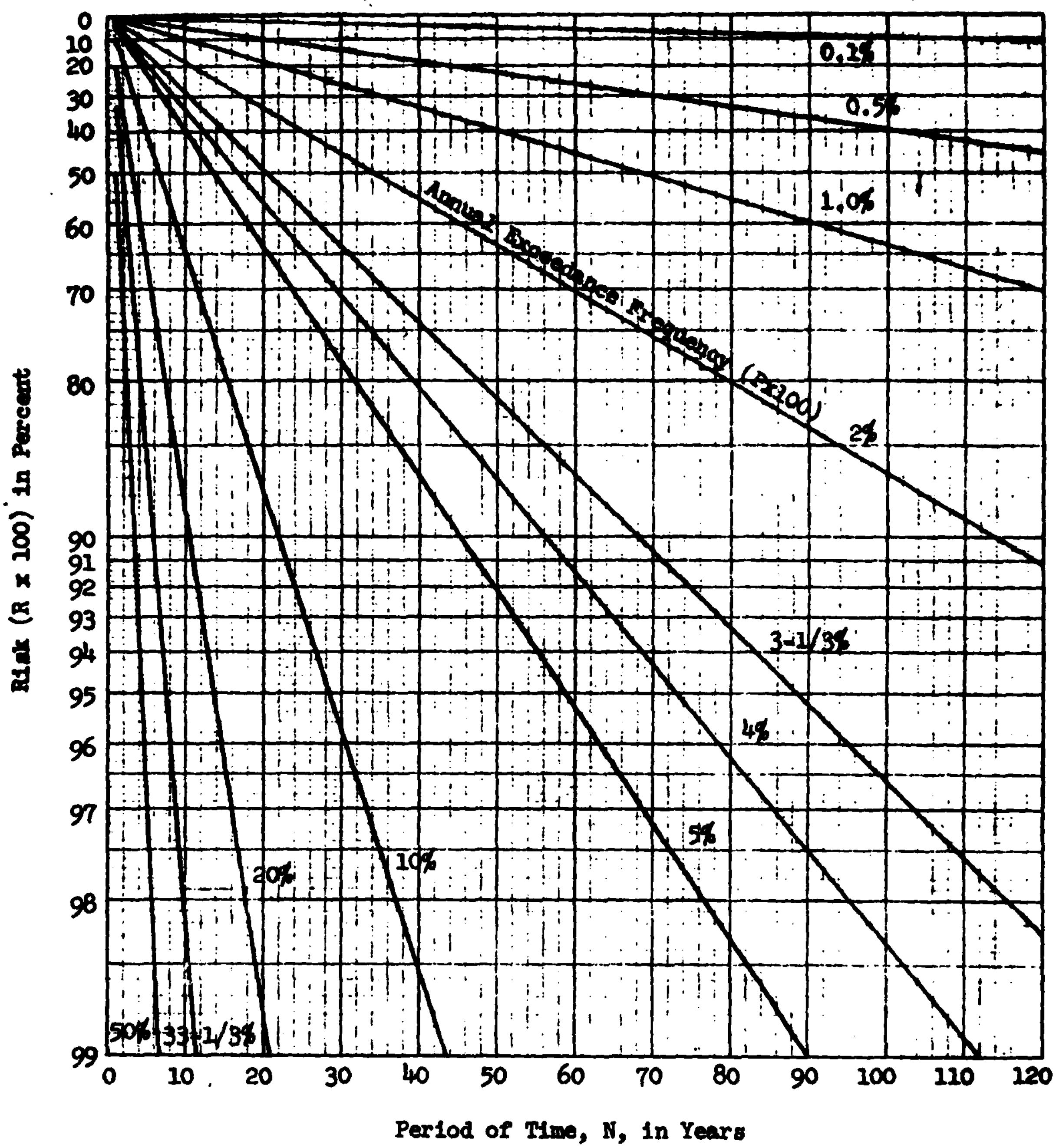
Period of Time In Years	Risk (in percent) One or More Events
30	26
50	40
70	50
100	63

*From Appendix 10, "A Uniform Technique for Determining Flood Flow Frequencies (Draft)," U.S. Water Resources Council, 3 December 1974.

When assessing system performance using degree of protection or risk criterion the effectiveness of alternative measures or systems is determined by comparing these criterion at each location with each measure. While it is not likely that one degree of protection or one percent risk can be assigned to the system as a whole, it is still useful to assess effectiveness by looking at each location within a system. Used in this way degree of protection and risk provide a useful hydrologic criterion to complement the economic measures of performance.

Damage Reduction

Damage reduction is a measure of economic effectiveness, usually expressed as the actual dollar value of the difference in expected annual damages with and without proposed flood control measures or as a percentage of the total expected annual damages. Expected annual damages are computed as described previously and the reduction represents the flood control benefit of the measure or system being considered. As a measure of performance it tells how well a measure or group of measures is achieving



RISK OF ONE OR MORE FLOOD EVENTS EXCEEDING
A FLOOD OF GIVEN ANNUAL EXCEEDANCE FREQUENCY WITHIN A PERIOD OF YEARS

From Appendix 10, "A Uniform Technique for Determining Flood Flow Frequencies (Draft)," U.S. Water Resources Council, 3 December 1974.

its intended purpose, i.e., reducing damages caused by flooding. Because this reduction is expressed in average annual terms it is representative of the average damages likely to occur over a full range of hydrologic events.

Benefit-Cost Ratio

The most common measure of economic efficiency is the benefit-cost ratio, that is,dollar benefits per unit cost. As a measure of system performance it represents the capability of a system or measure to achieve its desired purpose (reduce flood damages) with a given amount of resources (capital, O&M and replacement costs). It is computed by dividing the total reduction in damages by the total cost of those measures required to achieve that reduction. Unlike damage reduction alone the benefit-cost ratio accounts for cost. This is important because it indicates how much must be committed to obtain that level of economic performance.

Net Benefits

Another measure of economic performance is net benefits. Usually expressed as average annual dollar benefits minus average annual dollar costs. In flood control planning it is an economic objective of formulation to maximize the net benefits. Flood control measures are added as long as each measure's net benefits are positive, or alternately the incremental benefit-cost ratio is positive. This insures a benefit-cost ratio equal to or greater than one (the minimum acceptable level of efficiency). Net benefits complement the other two economic performance criteria, damage reduction and benefit-cost ratio; damage reduction being

a measure of the expected reduction in economic loss, benefit-cost ratio the measure of economic efficiency and net benefits the total dollar contribution of the plan.

TABLE

Summary of
System Performance Criteria

Criteria	Units	Measures
Degree of Protection	exceedance interval, years	hydrologic effectiveness
Risk	percent chance	hydrologic effectiveness
Damage Reduction	average annual dollars	economic effectiveness
Benefit-Cost Ratio	dollar benefits per dollar cost	economic effectiveness
Net Benefits	average annual dollars	economic effectiveness

REFERENCES

1. The Hydrologic Engineering Center, U.S. Army, Corps of Engineers, "HEC-5C, Simulation of Flood Control and Conservation Systems," Users Manual, November 1974.

2. Eichert, Bill S., "HEC-5C, A Simulation Model for System Formulation and Evaluation" in Proceedings of a Seminar on Analytical Methods in Planning, The Hydrologic Engineering Center, U.S. Army, Corps of Engineers, March 1974.

3. Johnson, William K., "Approaches for Developing Alternatives in Planning," Water Resources Bulletin, American Water Resources Association, Vol. 10, No. 5, October 1974.

4. U.S. Army, Corps of Engineers, Engineering Circular 1105-2-12, "Evaluation of Economic Benefits for Flood Control and Related Water Resources Planning," 28 June 1974.

5. Hagen, Vernon K., "Formulating Flood Control Capability of Water Resource Projects," in Proceedings of a Seminar on Hydrologic Aspects of Project Planning, The Hydrologic Engineering Center, U.S. Army, Corps of Engineers, March 1974.

6. U.S. Army, Corps of Engineers, Engineering Pamphlet 1165-2-1, "Digest of Water Resources Policies," January 1975, page A-35.

PART II

FALL RIVER: AN EXAMPLE USING HEC-5C

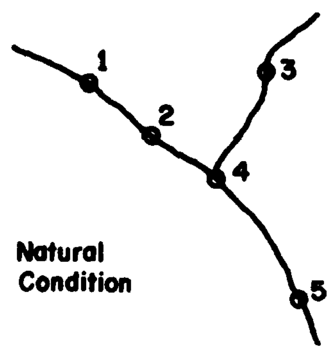
If it were desired simply to provide flood protection at a single location and assess the performance of alternative measures, computer simulation may not be necessary. But where many locations are involved and these locations are interrelated such that what happens at one location influences another, then computer simulation can make a significant contribution to both formulation and assessment. HEC-5C is a simulation model which simulates the operation of flood control systems and can accommodate all of the flood plain management measures discussed previously. It has the capability to compute net benefit information for use with the 'first' and 'last added' formulation strategies. Once formulated, a system's performance can be assessed using hydrologic and economic information output by the model.

To illustrate the use of the program, the Fall River System shown on the next page will be used. In its natural (unregulated) condition, flooding caused extensive flood damages in the vicinity of control point 4. To reduce flood damages, two reservoirs have been constructed in the basin at control points 1 and 3. Although they have been effective in reducing damages, flooding still occurs and an array of measures are being investigated to help reduce the remaining flood hazard. Each of these systems - natural (unregulated), existing, and those with proposed measures will be analyzed using HEC-5C. A brief discussion of the input data cards

required to model each condition and some of the output results are contained in the text. Appendix I contains selected output.

Natural (Unregulated) Condition

A major storm which occurred 5-10 June 1952 was selected from hydrologic records to be representative of major flood events. Local inflows to the river resulting from this storm were computed at five control points using unit hydrograph techniques. Table 1 summarizes the results in 6-hour time periods. Also, shown in Table 1 are channel capacities and routing criteria for the river system. Figures 1 and 2 show the stage-discharge and discharge-frequency relationships for control point 4, also developed from hydrologic studies.



Damage surveys in the vicinity of control point 4 were conducted in 1952 and have been updated periodically. A stage-damage relationship for control point 4 is shown in Figure 3. Expected annual damages are computed by combining the stage-damage and stage-discharge relationships into a discharge-damage curve (Figure 4), combining this with the discharge-frequency curve to obtain the damage-frequency relationship

(Figure 5) and then integrating under the curve. These data are presented in tabular form in Table 2.

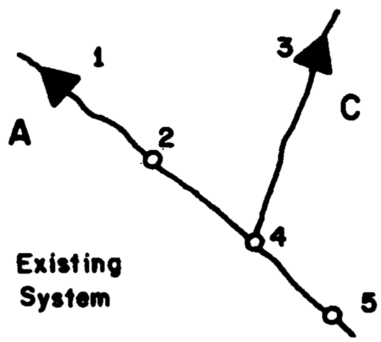
All necessary data to simulate the river system in its natural condition has been developed. These data are arranged according to the input format for HEC-5C. Input data and the simulation output are shown in the Appendix I, pages 2 through 15. Because of a requirement in the HEC-5 program that the control point furthest upstream be a reservoir, it is necessary to put in a dummy reservoir at control points 1 and 3. Thus, two sets of reservoir cards RL, RO, RS, and RQ are included to represent these reservoirs. Since they store no water, they have no effect on the system.

Only the simulation results for flood number 2, ratio 1.0, are shown in the output data. The other flood ratios .3, 1.5, 2.0, 3.0 and 4.0 were computed and printed out, but are not included to keep Appendix I brief.

Results of the simulation indicate that expected annual flood damages for the base (natural) condition are $1,721,300 (Appendix I, page 12). Since there were no modifications, there is no reduction in damage and all damages result from uncontrolled runoff. The maximum (6-hour average) flow occurring at control point 4 is 194,036 cfs (Appendix I, page 9) for flood 2. The nondamaging channel capacity is 35,000 cfs. From the frequency plot for control point 4 the exceedance interval for the nondamaging flow is approximately 1 year.

Existing System (Reservoirs A and C)

The sketch below shows the Fall River system with flood control reservoirs located at control points 1 and 3. This is the system as it now exists. To simulate the system operation, information is needed about reservoir storage levels, outlet capacity, and operating criteria. A summary of this information is tabulated in Table 3. Input cards J1, J2, RL, RO, RS, RQ and ID are used to carry the data required to describe the two reservoirs. Appendix I, pages 16 through 28, shows both input and output data under this condition.



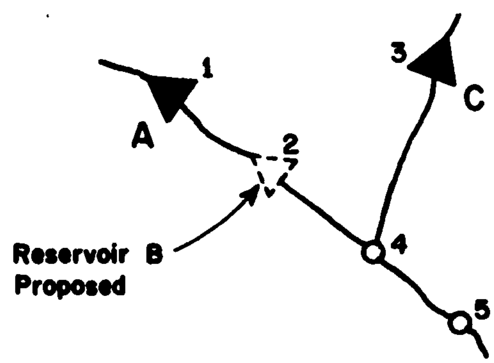
Adding two reservoirs to the natural system results in regulating the river flow below the reservoirs. Local inflow below the reservoirs, however, still remains uncontrolled. A 10% contingency allowance is made for forecasting streamflow two time periods in advance. These data are shown in fields 2 and 3 of the J2 card. The effect of regulation on the basic curves used to compute flood damages is to modify the discharge-frequency curve at all downstream control points. This modified curve is computed internally in the program using results from several simulations for a range of selected flood ratios. See Appendix I, page 27, for

a printer plot of these data. The nondamaging flow is still 35,000 cfs, and from the modified frequency plot the degree of protection is now approximately 2 years.

Simulation results show expected annual flood damages at control point 4 of $696,320 with the two reservoirs (Appendix I, page 28). This is a reduction in damages from natural conditions of $1,024,470. Uncontrolled local flow causes an expected $525,750 in annual damages. For flood 2 the maximum flow occurring at control point 4 is 92,483 cfs (Appendix I, page 23). This is a substantial reduction (101,548 cfs) over unregulated conditions.

Reservoir B at C.P. 2

A reservoir is proposed for control point 2, shown below, as a means to further reduce flood damages at control point 4. The storage, outlet capacity, and operating criteria of Reservoir B were obtained from preliminary design studies and are tabulated in Table 4. The major effects of Reservoir B are to control local runoff between control points 1 and 2, and to store water above the capacity of Reservoir A. This modifies the discharge-frequency relationship at control point 4, and further reduces flood damages.



To simulate the system with Reservoir B added, it is necessary to input at control point 2 the reservoir information shown in Table 4. This is done by using the RL, RO, RS, and RQ cards. The ID card is modified to indicate that a reservoir exists at control point 2. Since any reduction in potential damages brought about by the reservoir must be computed as a reduction from damages anticipated under existing conditions, the damages remaining with the existing system - $696,820 - are input using the DB card. Appendix I shows the specific input changes.

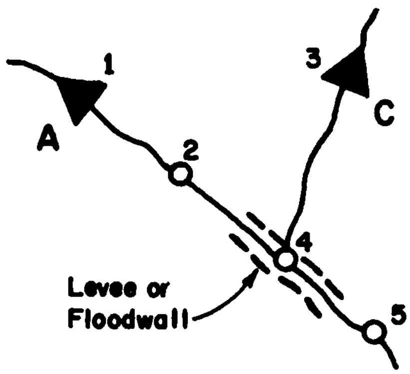
Tabulated on Table 5 are cost data for Reservoir B and other flood control measures. These data are input using the R$ card for the capital cost, and the CP card for the percentage of the capital cost estimated for operations and maintenance. The capital recovery factor is also input using the CP card.

Results of the simulation show expected annual flood damages with Reservoir B in place to be $214,550 (Appendix I, page 42). This is an annual reduction of $482,270. Flood condition number 2 results in a maximum average 6-hour flow of 34,000 cfs at control point (Appendix I, page 36). The degree of protection with Reservoir B is between 10 and 15 years as determined from the modified frequency relationship at the nondamaging flow of 35,000 cfs.

Levee or Floodwall

Another alternative measure is to provide local protection in the form of levees or floodwalls along the main river channel in the vicinity

of control point 4. The primary hydrologic effects of levees or floodwalls is to increase non-damaging channel capacity by raising the channel sides, and to alter the routing criteria in the vicinity of the modification. This results in a change to the stage-discharge, stage-damage, and discharge-damage relationships at the control point.



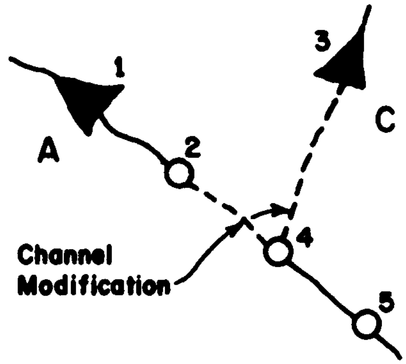
In the simulation model, increased channel capacity is taken into account by changing the maximum value specified on the CP card. The change to the stage-damage relationship may be handled in either of two ways. The first is to specify a design discharge on the C$ card corresponding to the maximum nondamaging stage (Figure 6 and 7). No damages would be computed below this value. The second approach is to input on the DC cards, a modified discharge-damage relationship showing zero damages below the nondamaging discharge (Figure 8). Taking this latter approach, two sets of discharge-damage functions - one base condition, one modified condition - are prepared as input. This is shown in Appendix I, page 44. In this example, the routing criteria and stage-discharge relationship were not modified to account for the change in river cross-section because it was

assumed the levee or floodwall would not extend very far either upstream or downstream of control point 4; hence, the hydrologic effect would be small. If it were desired to change these functions it would be necessary to develop storage-outflow relationships for the reach, or based upon experience with similar levee or floodwall measures, make an estimate of what this new criteria might be. Whether or not this would be worthwhile depends upon the extent of the change and the level of detail desired in the study.

The simulation results indicate expected annual damages were reduced $441,000 (Appendix I, page 56) and that there will remain $255,020 in damages. The maximum 6-hour flow for flood 2 at control point 4 was 110,411 cfs (Appendix I, page 51). The degree of protection would be 30-40 years and the nondamaging channel capacity 237,000 cfs.

Channel Modification

Modification of the existing channel between control points 2, 3 and 4 offers another way to reduce flood damages. This measure includes cross-section enlargement, straightening, and clearing and snagging. The objective is to increase the channel carrying capacity to pass the same flow at a lower stage, or alternately, to pass a greater flow at the same stage. The hydrologic effects of channel modifications are similar to those caused by levees and floodwalls - increased nondamaging channel capacity, modified stage-discharge relationship, and modified routing criteria.



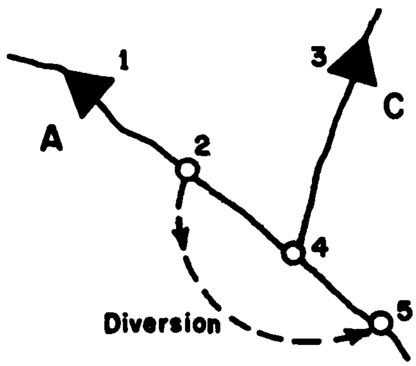
Increased channel capacity is input into the simulation model using the CP card. The change in the stage-discharge (Figure 9) relationship caused by an enlarged channel cross-section must be computed external to the model then combined with the stage-damage relationship (Figure 3) to produce modified discharge-damage data (Figure 10). These data for the modified relationship are then input using a second set of DC cards for corresponding values on the DQ cards. It was estimated that the channel modification would change the Muskingum X from X = 0.3 to X = 0.1 and K from 6 hour to 5 hour for reaches 2 to 4 and 3 to 4. (A more accurate estimate of routing effects could have been made by computing storage-outflow curves for natural and modified conditions using backwater techniques, and then using the Modified-Puls channel routing method.) The nondamaging channel capacity at control point 4 would be 65,000 cfs. These changes are reflected on the RT and CP cards.

Results shown in Appendix I, page 70, indicate that expected annual damages were reduced $271,640 due to channel modification. Damages remaining amount to $425,100 on an average annual basis. The maximum flow at

control point 4 for flood 2 was computed as 91,201 cfs (Appendix I, page 65). Degree of protection is approximately 5 years for a nondamaging flow of 65,000 cfs.

Diversion

Frequently, where the topography is flat and relatively large areas are available to store water temporarily, flow is diverted from the main river around a potential damage center, to re-enter at some point downstream. This measure is illustrated in the sketch below. Flow is diverted at control point 2, routed to control point 5 where it re-enters the main channel. The obvious hydrologic effect is to reduce the peak discharge at location 4 which results in a modified discharge-frequency curve at control point 4 and a corresponding reduction in damages. The amount of this reduction depends upon the amount of water diverted.



To account for this measure it is necessary to input into the model the locations where flow is being diverted and returned, the rate of diversion and return flow, and the routing criteria by which the diversion

flow is to be routed. In this example, the magnitude of the diversion varied as a function of the streamflow as shown below:

Control Point 2

Streamflow	0	30,000	50,000	70,000	90,000	110,000
Diversion	0	0	22,000	37,500	45,000	51,000

Streamflow	130,000	150,000	190,000
Diversion	55,000	58,500	62,500

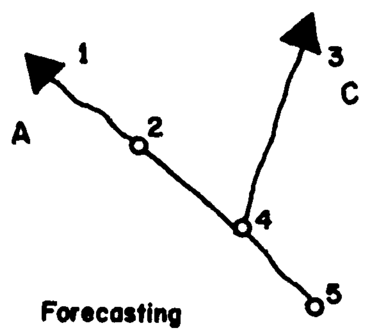
These data were input using the QS and DQ cards at control point 2 (see Appendix I, page 72). It was also determined that 90% of the flow would return to the main channel at control point 5, and that the diversion flow would be routed between control point 2 and control point 5 using a Muskingum X = .15, K = 24 hour and four subreaches. Both of these criteria are input using the DR card at control point 2. The modified discharge-frequency relationship at control point 4 is computed internally by the model using the flood ratios selected earlier (Appendix I, page 83). The degree of protection from this modified curve is approximately 3 years for a nondamaging flow of 35,000 cfs.

Output from the simulation indicates expected annual flood damages were reduced $278,370, and $417,950 in expected damages still remain (Appendix I, page 84). The maximum flow at control point 4 is 53,779 cfs during flood number 2 (Appendix I, page 79).

Flood Forecasting

Flood forecasting is intended to provide advance information about rainfall and runoff conditions to assist in more efficient operation of

a flood control system. Hopefully, this advance information will help to minimize flood damages. The usual means of forecasting is with a network of monitoring stations feeding rainfall-runoff data into a central operations center. These raw data are used in analyses to forecast future system conditions. The principal effect of such a system is hydrologic - better data yields better system operation which in turn reduces flooding at damage centers.



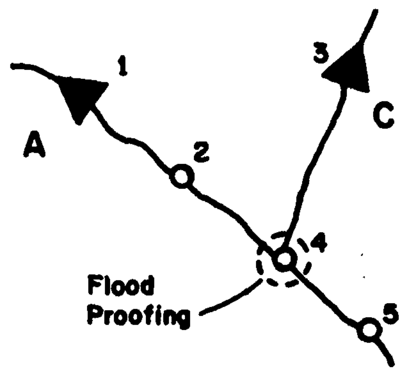
Forecasting

In the Fall River Basin operation of the existing system (Reservoirs A and C) assumes that flood discharges are known two 6-hour periods in advance with a 10% contingency allowance for local flows. To illustrate the effect of a flood forecast system it is assumed that the discharges are known six periods or 36 hours in advance with a 15% contingency factor. This information is input to HEC-5C by simply changing the contingency factor in field 2 and the forecasting period in field 3 of the J2 card (Appendix I, page 86). Results of the system simulation indicate expected annual damages are reduced $22,850. Damages remaining are $673,970, Appendix I, page 98, and the magnitude of flood peak is modified for each period (Appendix I, pages 90-91). The degree of protection

exceeds the protection provided by the existing system, although this does not have to be so, but depends upon the magnitude of the change in flow brought about by the forecasting.

Flood Proofing

Flood proofing has the effect of reducing damages below the upper limits of the flood proofing materials. Thus, flood flows below this elevation can be expected to cause limited or no damage; above this elevation expected damages will remain essentially unchanged from conditions without flood proofing. Since this measure is structure specific, the magnitude of the damage reduction depends upon the degree of flood proofing provided specific structures, and the aggregation of all structures. This change results in a modified stage-damage relationship (Figure 11) which produces a modified discharge-damage function (Figure 12) and damage-frequency curve. There is no hydrologic effect of flood proofing unless alterations are made to the flood plain which affect the cross-section of flood flow.



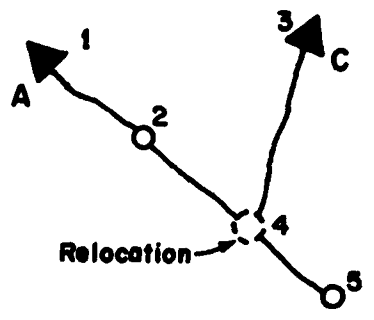
To account for flood proofing in the model it is only necessary to input the modified discharge-damage data (Figure 12). This can be done

by using another set of DC cards. The first set is input to compute expected annual damages under natural conditions. Input changes are shown in Appendix I, page 100.

Output from the simulation shows an expected annual damage reduction of $233,140 with $463,630 remaining (Appendix I, page 112). The maximum flow at control point 4 with flood number 2 is 92,483 cfs (Appendix I, page 101). The degree of protection with flood proofing is the same as with the existing system, approximately 2 years, since the measure does not affect the nondamaging flow at control point 4.

Relocation

A direct way to reduce flood damages at control point 4 is to relocate damageable structures out of the flood plain. This relocation results in modifying the stage-damage relationship as shown in Figure 13. This curve represents the situation where structures near the river are relocated out of the flood plain, but structures further away remain, thus the damages are reduced by the value of only those structures removed. When the modified curve is combined with the stage-discharge curve (Figure 1) a modified discharge-damage relationship results (Figure 14). The hydrologic effect of relocation is generally small, but could be significant if major flow obstructions were removed, in which case the channel capacity and routing criteria should be modified.

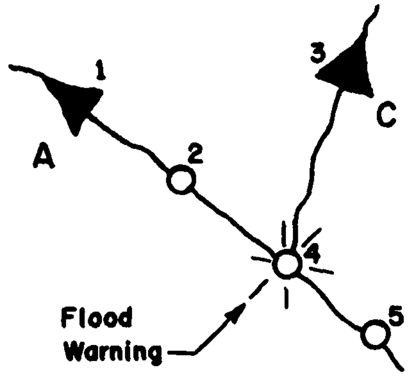


The change in stage-damage data is input into the model by modifying the discharge-damage function. This is accomplished by using a second set of DC cards to reduce damages at lower stages. Appendix I, page 100, shows the cards used. Note that the nondamaging flow is 130,000 cfs.

Simulation results indicate expected annual damages are reduced by $416,750, with $280,070 remaining (Appendix I, page 126). Since there is no hydrologic effect the magnitude of the flow at control point 4 remains unchanged from the existing system - 92,488 cfs. The degree of protection is approximately 20 years.

Flood Warning

Flood warning allows action to be taken to protect or remove damageable property. While flood forecasting is associated with gaining advance information for better system operation, flood warning is associated with advance information for protecting property. The principle effect is economic in that the stage-damage function is altered by lowering potential damages when a warning is effective.



At control point 4 in the Fall River basin it is assumed that a warning system can be implemented and property protected or removed above flood stage. The discharge-damage relationship is modified by assuming a 5% reduction in damages at every flood stage. The new damage data is input to HEC-5C using a second set of DC cards.

The simulation output shows a reduction in damages of $35,190. There is no reduction in flow at control point 4. The degree of protection is the same as for the existing system.

System Formulation and Assessment

Because of the simplicity of the Fall River system, it is difficult to illustrate all the principles of system formulation discussed in part I. Table 6 summarizes damage, cost and benefit information at control point 4 for each measure. The net benefits represent the net benefits in the first added position. Using the first added strategy, relocation would be selected as the measure contributing most (maximum net benefits) to national economic development and thus, using economic criterion alone, would be added to the existing system. To move to the second stage using this strategy it would be necessary to modify the stage-damage and discharge-damage functions at control point 4 to reflect the annual $416,750 reduction in damage brought about by the relocation. The new system which includes relocation would then be simulated, damages remaining computed, and each measure added one at a time. This was not done in this example because it was obvious that damage reduction from relocation was sufficiently

large that none of the remaining measures in the 'first added' position could produce positive net benefits. Thus, it was only necessary to complete the first stage computations to make a decision.

The 'last added' strategy is difficult to apply to the Fall River example because all measures except the reservoir at control point 2 and flood forecasting occur at control point 4. This requires that a combined stage-damage and stage-discharge relationship be developed with all measures and with each measure deleted. This is no small taks.

The economic performance of all measures is also summarized in Table 6. The most effective measure is a reservoir at control point 2. It is most effective because it does the best job of reducing flood damages - $432,270. However, it is highly inefficient from the economic standpoint. A very large amount of capital is required to construct the reservoir and as a result the net benefits are negative. Flood warning is the most efficient measure, yielding the greatest dollar benefit per dollar invested - 3.23. Using economic criterion alone the measure which would be added to the existing system would be relocation, not because it is most effective (damage reduction) or most efficient (B/C), but because it adds the most to the national economic development account - $131,950. Each assessment gives a somewhat different perspective of performance, and together help to describe a measure's total performance in economic terms.

Table 7 presents a summary of the hydrologic performance of each measure in terms of its expected degree of protection. A range of

protection is given because none of the flood ratios were controlled to just the nondamaging flow. As shown a levee or floodwall yields the greatest protection for any single measure.

TABLE 1

HYDROLOGIC INFORMATION
Natural Condition

Control Point Inflows*- June 5-10, 1952 STORM

Date	Time	Inflow to C.P.1 (cfs)	Inflow C.P.1 to C.P.2 (cfs)	Inflow to C.P.3 (cfs)	Inflow C.P.2,3 to C.P.4 (cfs)	Inflow C.P.4 to C.P.5 (cfs)
5 Jun	2400	1,000	2,000	3,000	2,000	1,000
6 Jun	0600	2,000	3,000	6,000	4,000	2,000
	1200	3,000	4,000	27,000	19,000	9,000
	1800	18,000	6,000	60,000	13,000	6,000
	2400	37,000	20,000	105,000	10,000	5,000
7 Jun	0600	42,000	57,000	78,000	7,000	3,000
	1200	50,000	100,000	60,000	4,000	2,000
	1800	27,000	90,000	45,000	1,000	500
	2400	20,000	70,000	33,000	1,000	500
8 Jun	0600	13,000	50,000	24,000	4,000	2,000
	1200	5,000	37,000	18,000	10,000	5,000
	1800	4,000	24,000	12,000	25,000	12,000
	2400	3,000	24,000	12,000	13,000	6,000
9 Jun	0600	2,000	15,000	9,000	7,000	4,000
	1200	1,000	9,000	6,000	4,000	2,000
	1800	1,000	3,000	3,000	2,000	1,000
	2400	1,000	2,000	2,000	1,000	500
10 Jun	0600	1,000	1,500	1,000	500	200

*Average inflow for the period.

Control Point Hydraulics

	C.P.1	C.P.2	C.P.3	C.P.4	C.P.5
Channel Capacity (cfs)	6,000	21,000	12,000	35,000	37,000

Routing Criteria All Reaches
Muskingum Routing
Δt = 6 hours K = 6 hours X = .3

TABLE 2

ECONOMIC INFORMATION
Control Point 4, Unregulated Conditions

Exceedence Frequency	Stage (ft)	Discharge (cfs)	Damages
.999	3.6	28,800	0
.900	4.0	35,000	0
.800	4.3	42,000	$ 180,000
.700	4.5	50,500	380,000
.600	5.5	60,500	500,000
.500	5.8	73,000	630,000
.400	6.4	90,000	900,000
.300	7.2	114,000	1,250,000
.250	7.7	130,000	1,500,000
.200	8.2	150,000	1,930,000
.150	8.9	180,000	2,660,000
.100	10.0	230,000	5,000,000
.050	11.8	323,000	9,900,000
.020	14.5	490,000	12,220,000
.010	16.6	640,000	13,350,000
.005	18.9	840,000	14,150,000
.002	20.2	1,000,000	14,600,000

NOTE: See Figures 1 through 5 for a graphic display of these data.

TABLE 3

RESERVOIR INFORMATION - RESERVOIRS A AND C
Existing System

Reservoir Storage

	Level	Storage (ac-ft) A	Storage (ac-ft) C
Top of Surcharge	4	200,000	1,000,000
Top of Flood Control	3	150,832	755,408
Top of Conservation	2	50,000	100,000
Top of Inactive Storage	1	0	0

Reservoir Outlet Capacity

Reservoir A Storage (ac-ft)	Reservoir A Outlet Capacity (cfs)	Reservoir C Storage (ac-ft)	Reservoir C Outlet Capacity (cfs)
50,000	6,000	100,000	12,000
70,000	7,000	200,000	18,000
100,000	8,000	400,000	30,000
150,832	100,000	700,000	80,000
200,000	200,000	800,000	150,000
		1,000,000	500,000

Operating Criteria

- Two 6-hour periods of foresight on all inflows and local flows will be used in the system operation for all reservoirs.

- Below the top of flood control pool, reservoir releases will be made so as not to exceed the channel capacity at any downstream control point for which the reservoir operates. As soon as it can be determined (using assumed forecasting capability) that the reservoir will exceed the top of flood control pool, releases will be made equal to the channel capacity at the dam site. Above the top of flood control, releases will be made equal to inflow up to the maximum outlet capacity.

- The maximum rate of change of reservoir release is equal to the channel capacity at the dam site.

- There are no minimum flow requirements.

- Each reservoir will be operated for CP 4 only.

- A 10% contingency allowance is made for local flows for the 12-hour forecast period.

TABLE 4

RESERVOIR INFORMATION - RESERVOIR B
Proposed Reservoir

Reservoir Storage

	Level	Storage (ac-ft)
Top of Surcharge	4	1,000,000
Top of Flood Control	3	654,576
Top of Conservation	2	100,000
Top of Inactive Storage	1	0

Reservoir Outlet Capacity

Reservoir B

Storage (ac-ft)	Outlet Capacity (cfs)
100,000	21,000
200,000	30,000
400,000	40,000
600,000	100,000
800,000	300,000
1,000,000	500,000

Operating Criteria

- Two 6-hour periods of foresight on all inflows and local flows will be used in the system operation for all reservoirs.

- Below the top of flood control pool, reservoir releases will be made so as not to exceed the channel capacity at any downstream control point for which the reservoir operates. As soon as it can be determined (using assumed forecasting capability) that the reservoir will exceed the top of flood control pool, releases will be made equal to the channel capacity at the dam site. Above the top of flood control, releases will be made equal to inflow up to the maximum outlet capacity.

- The maximum rate of change of reservoir release is equal to the channel capacity at the dam site.

- There are no minimum flow requirements.

- Each reservoir will be operated for CP 4 only.

- A 10% contingency allowance is made for local flows for the 12-hour forecast period.

TABLE 5

COST INFORMATION

Measure	Capital Cost	Percentage O&M Cost of Capital Cost	Annual Average O&M Cost	Total Average Annual Cost*
Reservoir at CP 2	59,150,000	1.2	709,800	4,199,650
Levee or Floodwall	5,510,000	1.0	55,100	380,190
Channel Modification	3,420,000	2.0	68,400	270,180
Diversion	10,520,000	0.8	84,160	704,840
Flood Forecasting	120,000	1.6	1,920	9,000
Flood Proofing	3,480,000	0.7	24,360	229,680
Relocation	4,450,000	0.5	22,250	284,800
Flood Warning	100,000	5.0	5,000	10,900

*Discounted at 5-7/8%, 100 yr., capital recovery factor $(\frac{A}{P})$ = .059

TABLE 6

SUMMARY OF SYSTEM ECONOMIC PERFORMANCE

Measure	Annual Damage with Proposed Measure	Expected Annual Damage Reduction	Annual Cost*	Annual Net Benefit*	B/C
Existing System Reservoirs A and C	$696,820	-	-	-	-
Reservoir at CP 2	214,550	482,270	4,199,650	-3,717,380	0.11
Levee or Floodwall	255,820	441,000	380,190	60,810	1.16
Channel Modification	425,180	271,640	270,180	1,460	1.01
Diversion	417,950	278,870	704,840	-425,970	0.40
Flood Forecasting	673,970	22,850	9,000	13,850	2.54
Flood Proofing	463,680	233,140	229,680	3,460	1.02
Relocation	280,070	416,750	284,800	131,950	1.46
Flood Warning	661,630	35,190	10,900	24,290	3.23

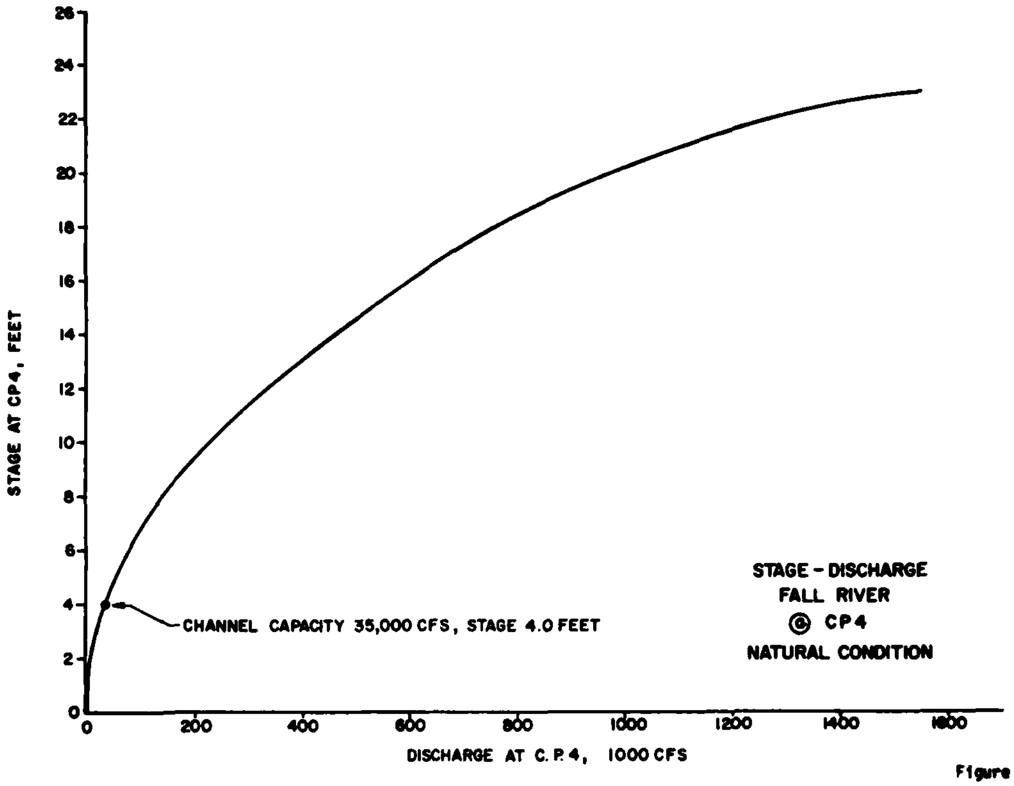
*Discounted at 5-7/8%, 100 yr., capital recovery factor $(\frac{A}{P})$ = .059

TABLE 7

SUMMARY OF SYSTEM HYDROLOGIC PERFORMANCE

Measure	Nondamaging Flow at CP 4 (cfs)	Approximate Degree of Protection* (exceedance interval, years)	Risk of Nondamaging Frequency Flood Being Exceeded in Next 10 Years (percent chance)
Natural (Unregulated)	35,000	1	-
Existing System Reservoirs A and C	35,000	2	> 99%
Reservoir at CP 2	35,000	12	~ 56%
Levee or Floodwall	287,000	35	~ 26%
Channel Modifications	65,000	5	~ 89%
Diversion	35,000	3	> 98%
Flood Forecasting	35,000	3	> 98%
Flood Proofing	35,000	2	> 99%
Relocation	180,000	20	~ 40%
Flood Warning	35,000	2	> 99%

*Obtained from interpolation between events with known frequencies (flood ratios) using the modified frequency curve computed and plotted for each measure.



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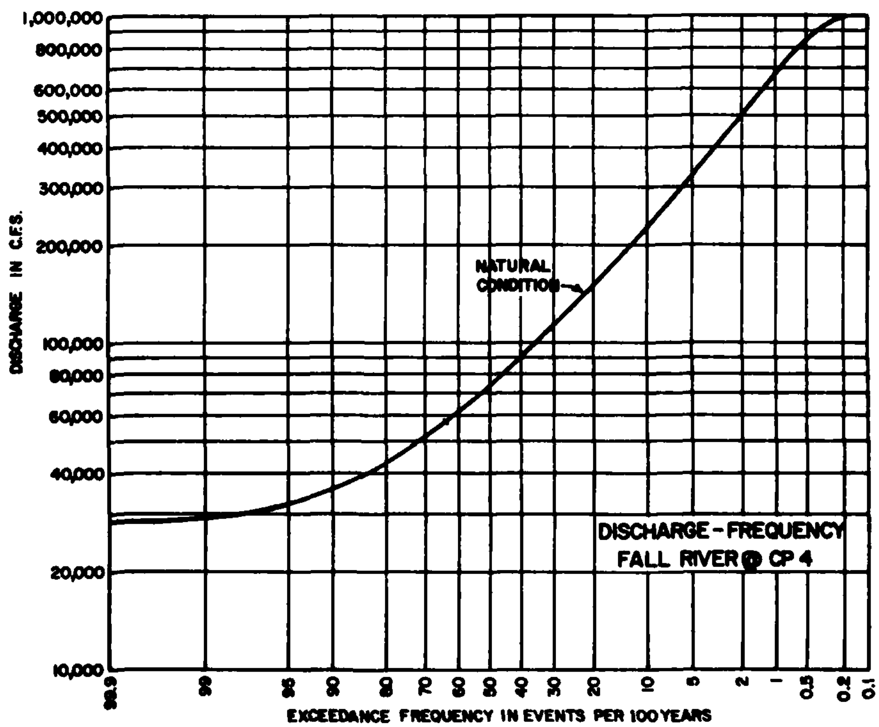

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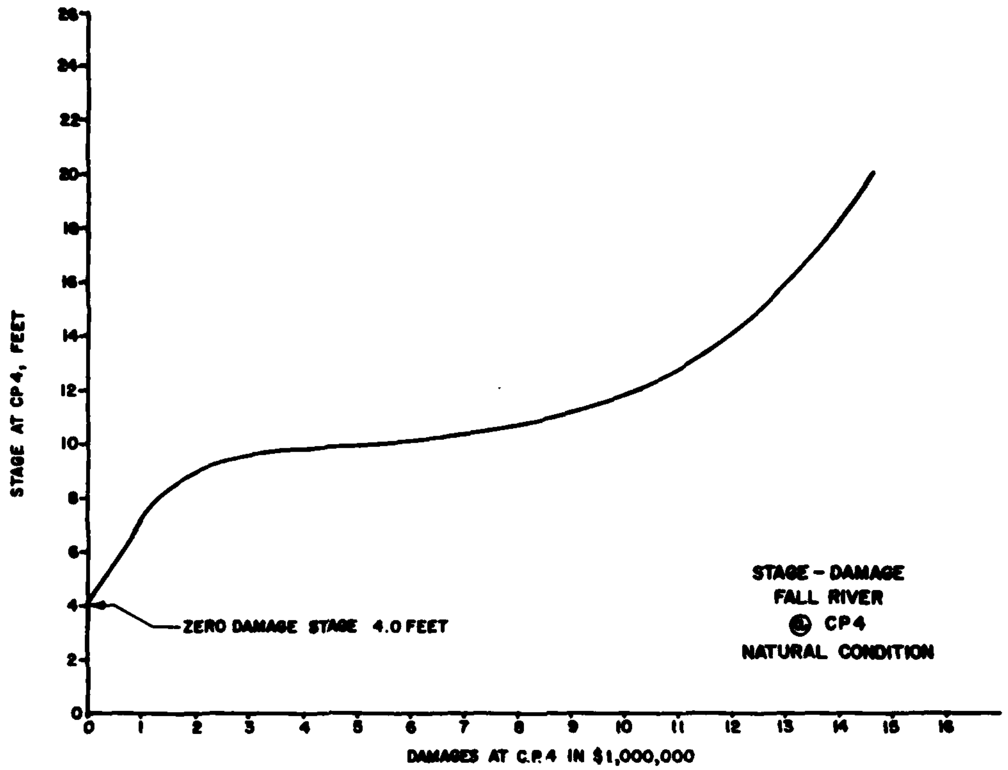
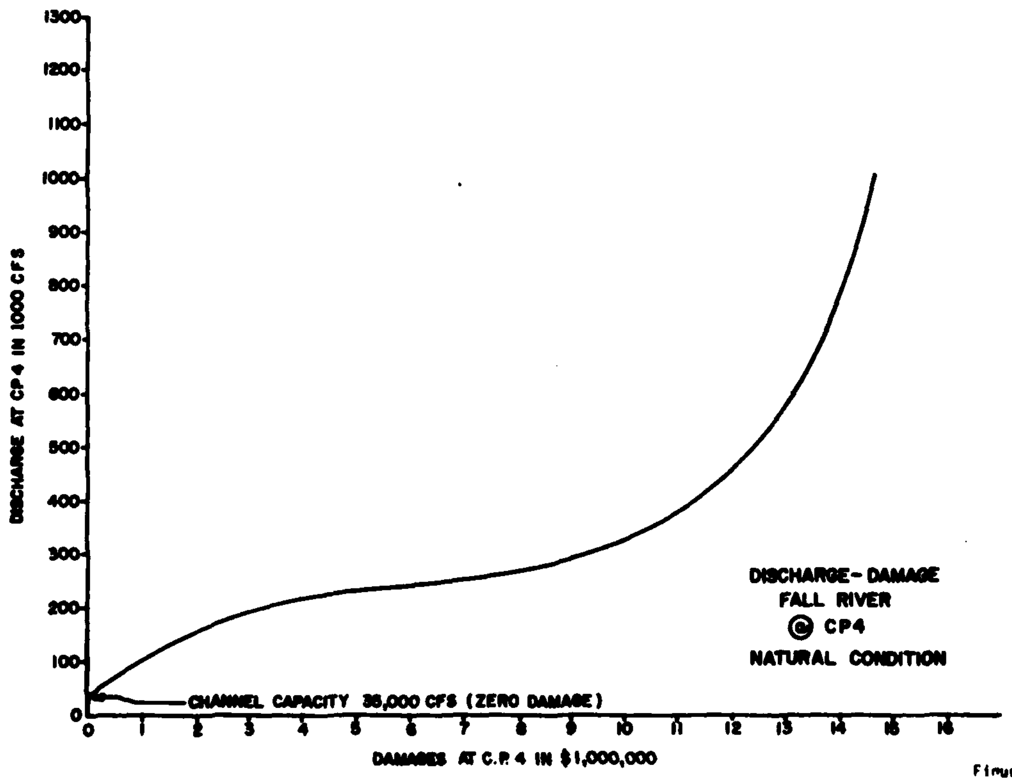


Figure 3



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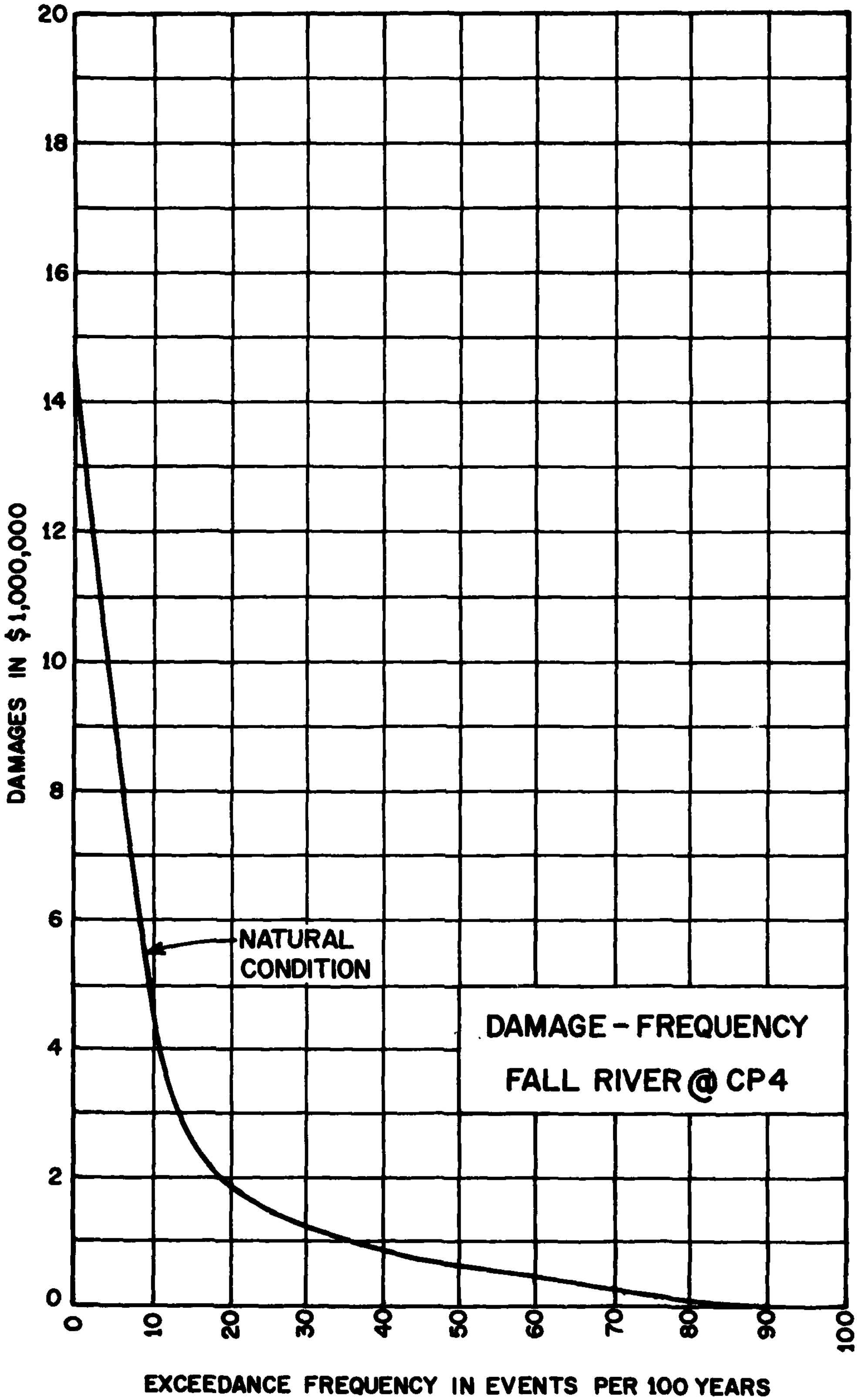
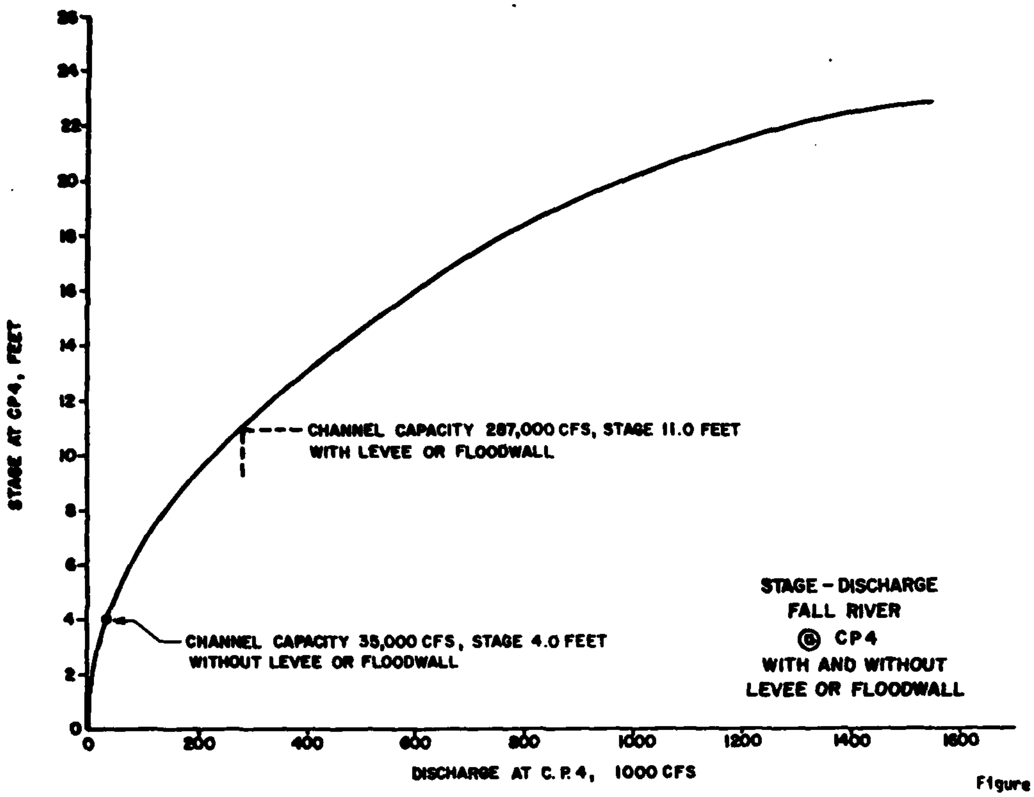

DAMAGES IN $1,000,000
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100
EXCEEDANCE FREQUENCY IN EVENTS PER 100 YEARS
NATURAL CONDITION
DAMAGE - FREQUENCY
FALL RIVER @ CP4

Figure 5



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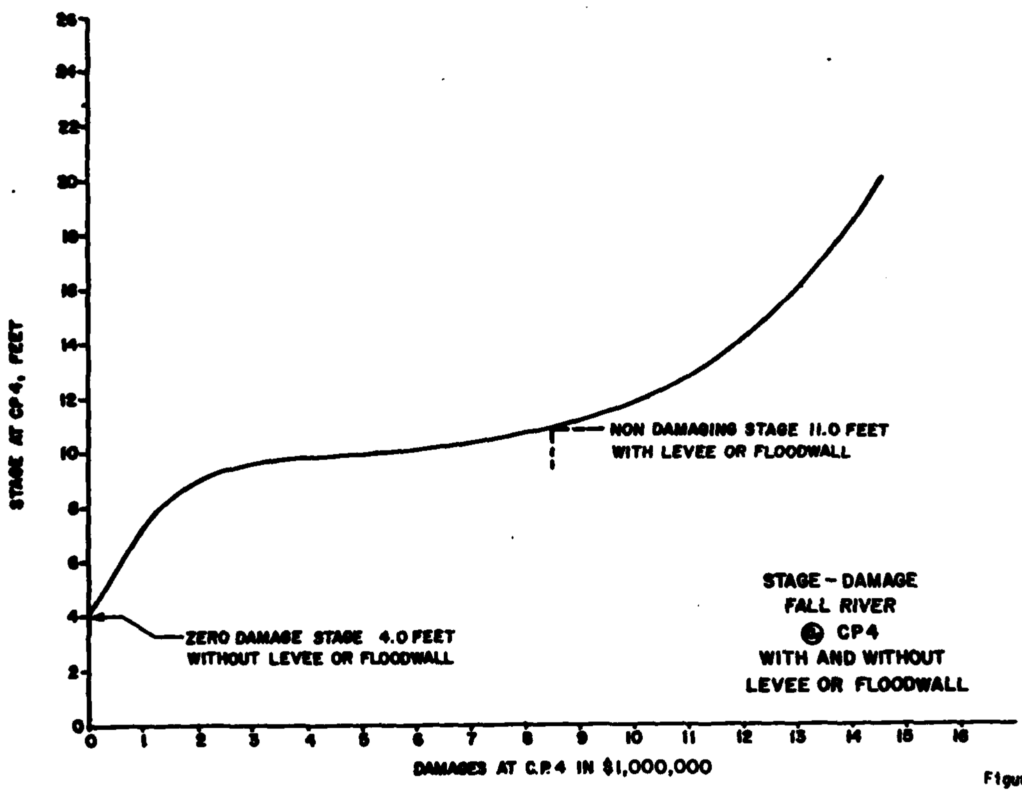

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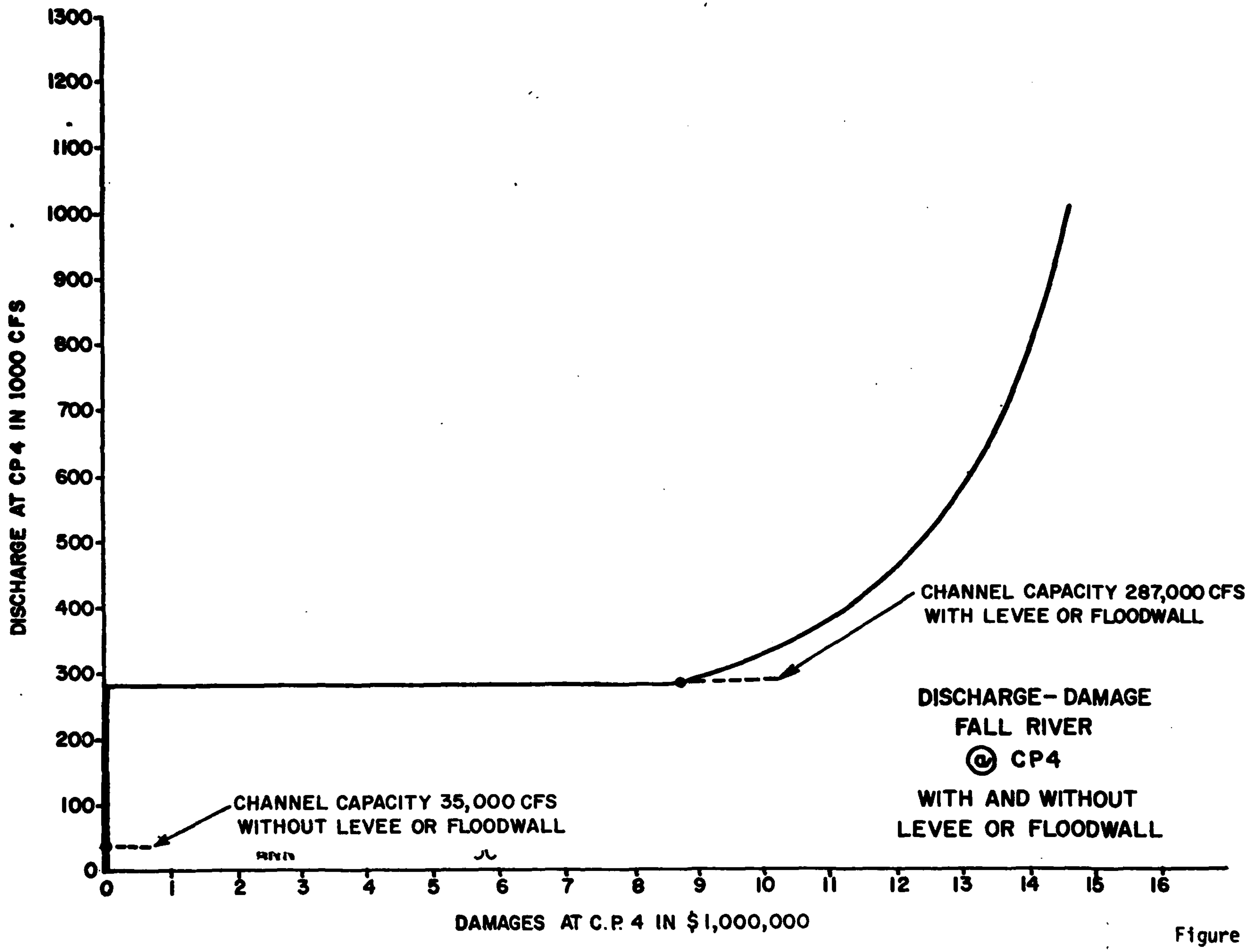
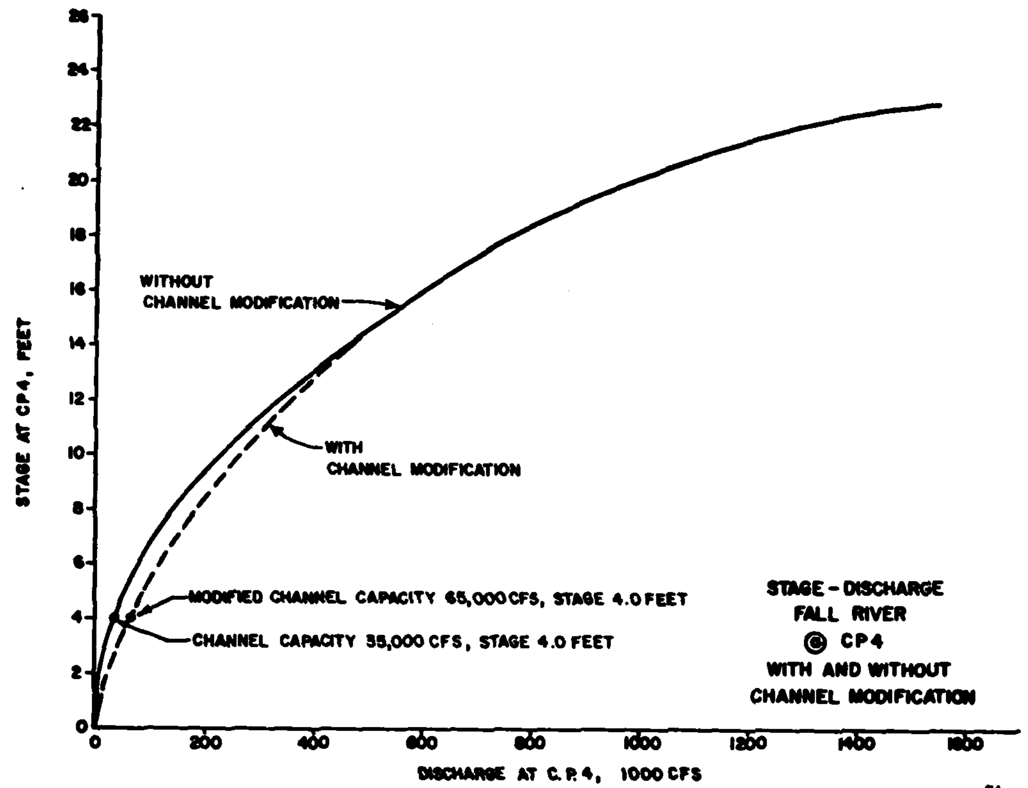


DISCHARGE AT CP4 IN 1000 CFS
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
DAMAGES AT C.P. 4 IN $1,000,000
CHANNEL CAPACITY 287,000 CFS
WITH LEVEE OR FLOODWALL
CHANNEL CAPACITY 35,000 CFS
WITHOUT LEVEE OR FLOODWALL
DISCHARGE- DAMAGE
FALL RIVER
@ CP4
WITH AND WITHOUT
LEVEE OR FLOODWALL

Figure 8



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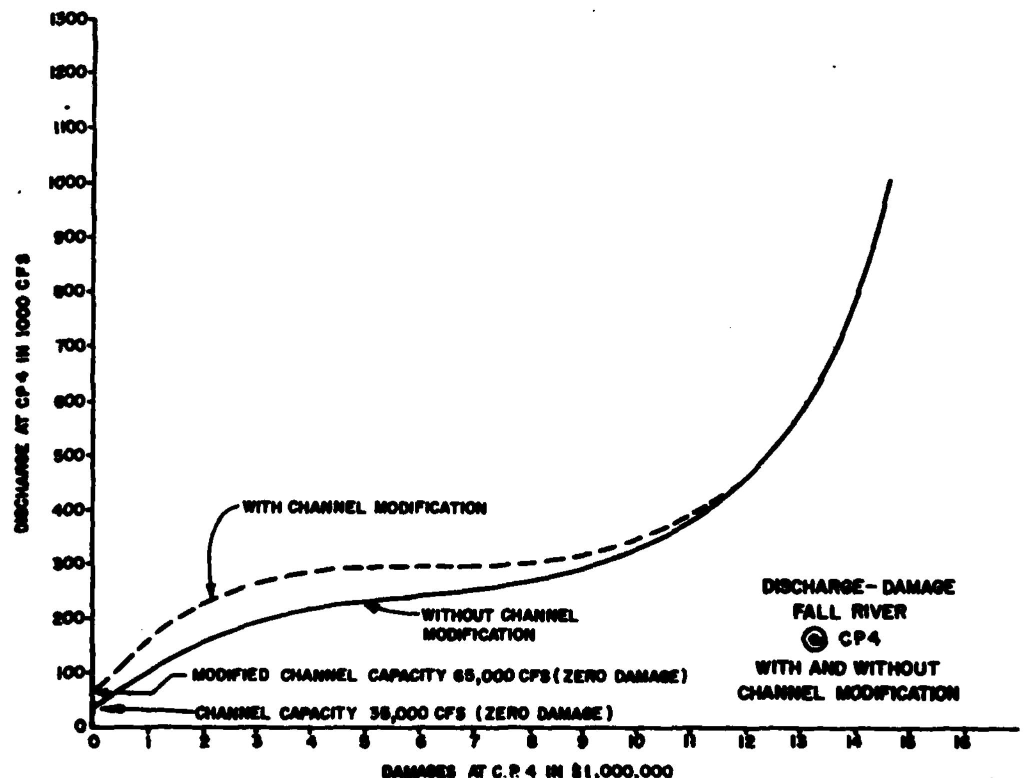

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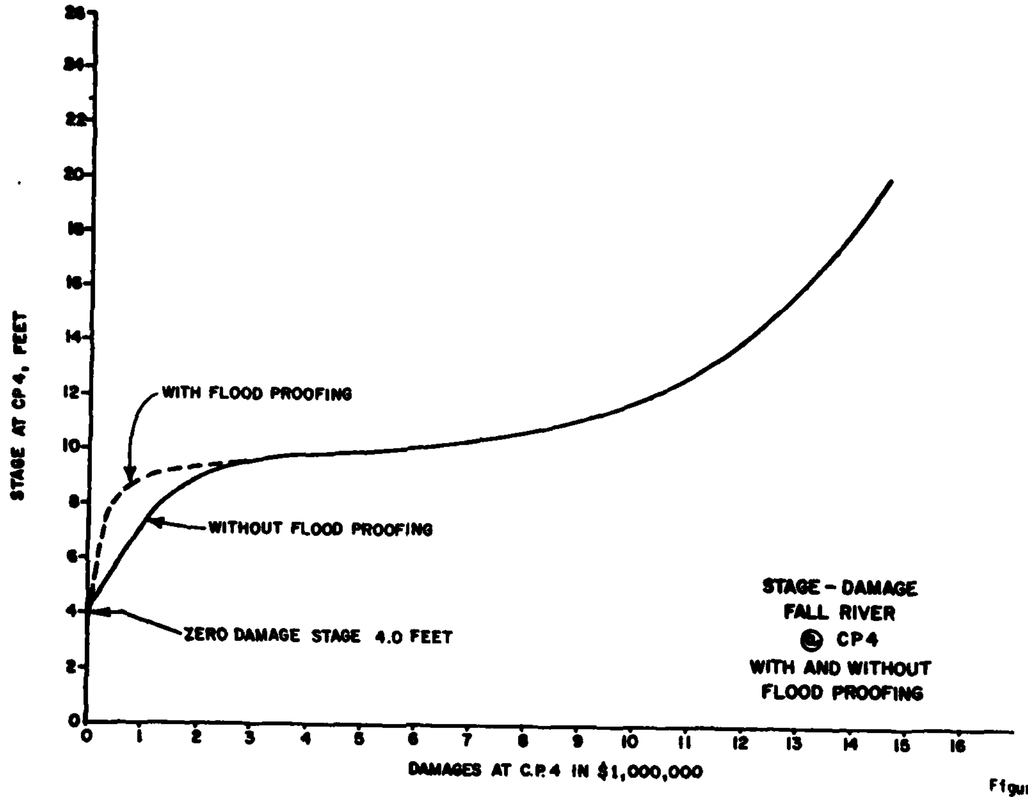

Figure 11

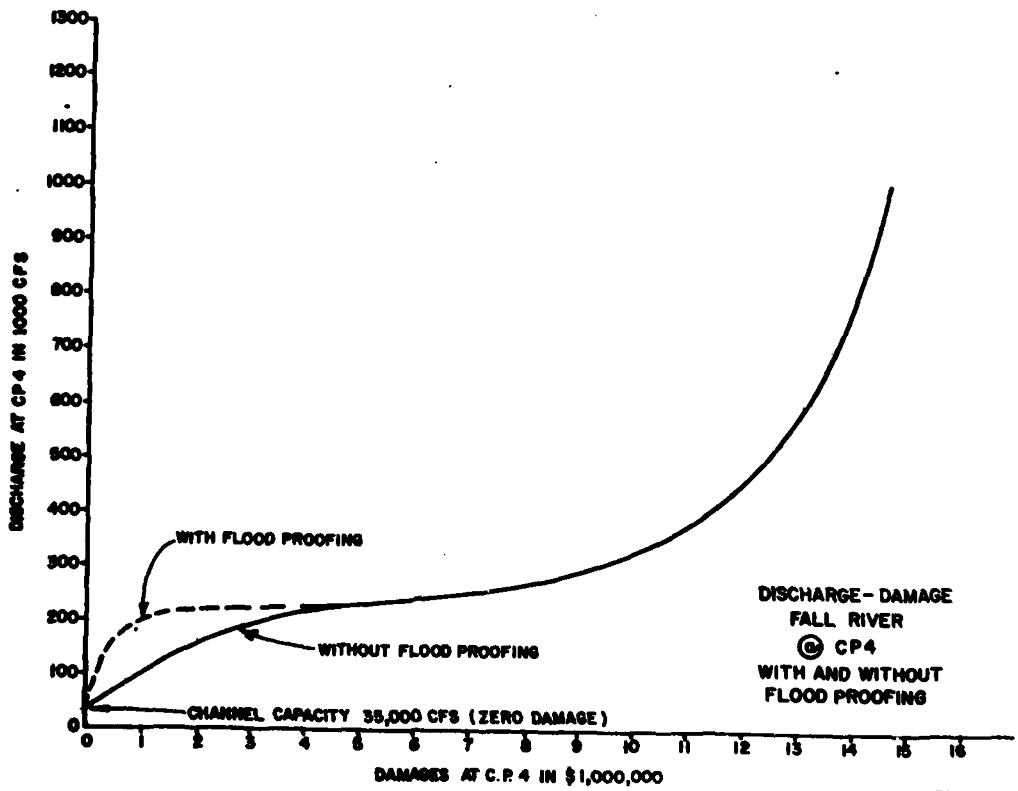

Figure 12

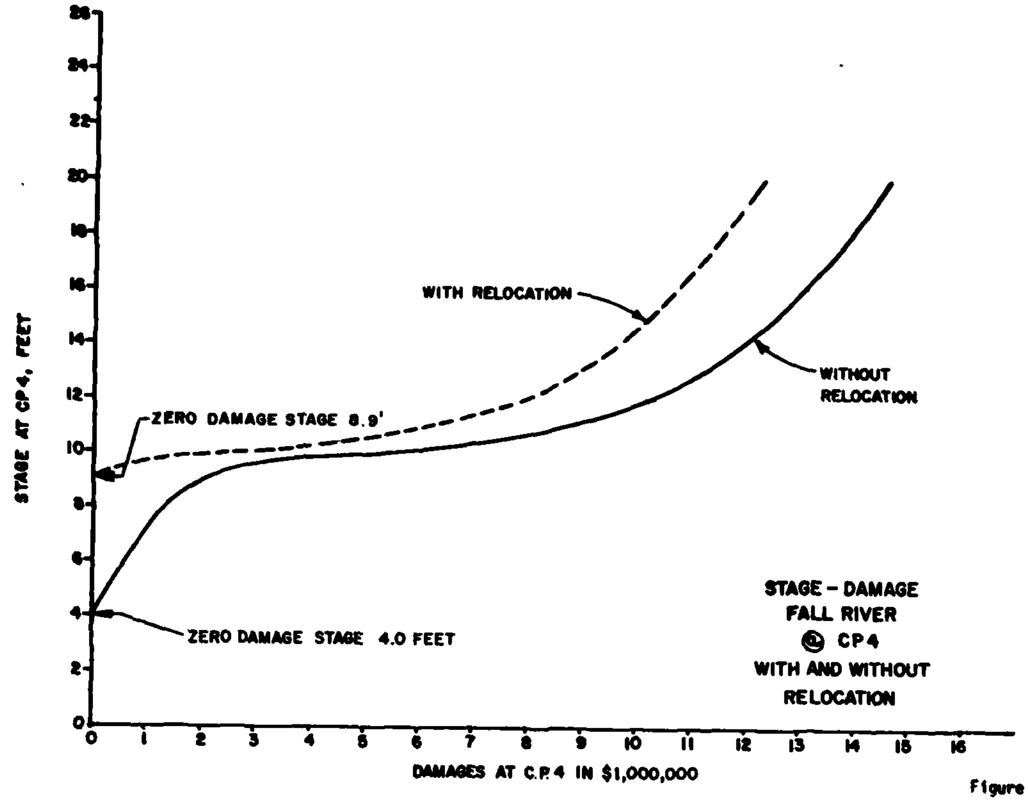

Figure 13

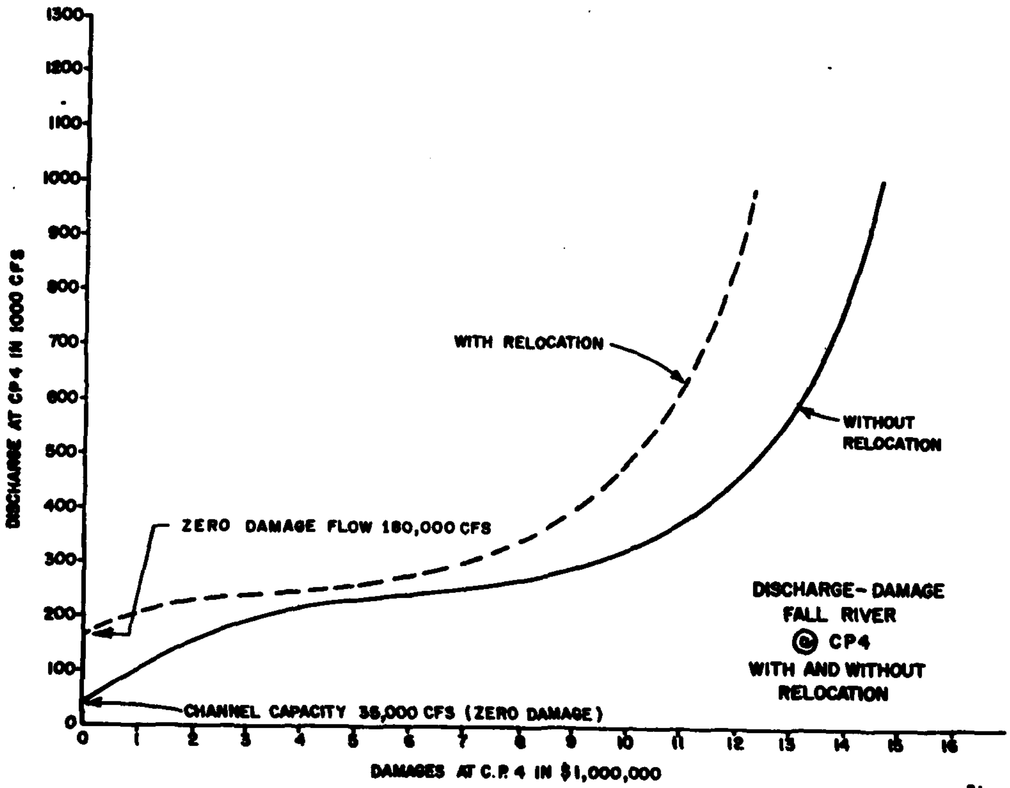

Figure 14

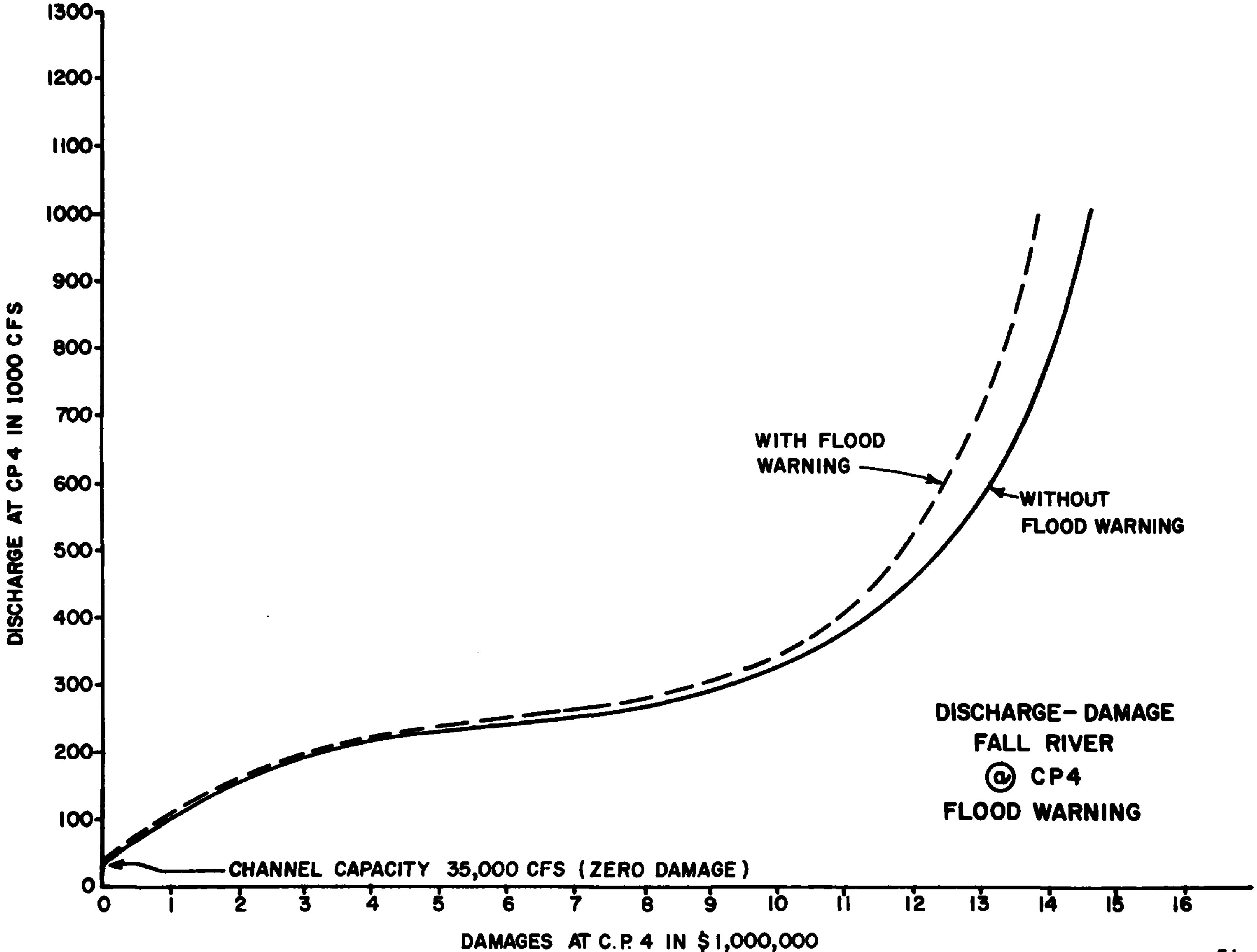
DISCHARGE AT CP 4 IN 1000 CFS
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
DAMAGES AT C.P. 4 IN $1,000,000
WITH FLOOD WARNING
WITHOUT FLOOD WARNING
CHANNEL CAPACITY 35,000 CFS (ZERO DAMAGE)
DISCHARGE-DAMAGE
FALL RIVER
@ CP4
FLOOD WARNING

Figure 15

PART III

APPENDIX I

FALL RIVER BASIN

TRAINING DOCUMENT NO. 7

HEC-5C SELECTED OUTPUT

Contents

FOREWORD

The purpose of this appendix is to supplement the discussion on the analysis of structural and nonstructural measures by providing selected output from computer program HEC-5C. Detailed output from the program would be too voluminous to reproduce here for the many flood control measures being discussed, so only selected portions are included. The selected portions include, (1) input data used for the simulation, (2) hydrologic data at each control point for flood number 2, (3) a summary of hydrologic data for each flood ratio, (4) expected annual flood damage data at control point 4, (5) a discharge-frequency curve plot for the input and modified conditions, and (6) summary of economic costs and performance.

Page 2
Natural Condition

```
HEC-2 VARIABLE OUTPUT MAR,1975
RES.= 75 CPTS.= 75 PERS.=100

T1 FALL RIVER BASIN   ***   NATURAL (UNREGULATED) CONDITION   ***
T2 TRAINING DOCUMENT NO. 7
T3 FLOOD RATIOS .3  1.0  1.5  2.0  3.0  4.0  USED TO COMPUTE ANNUAL DAMAGES
J1      10.00      6.00      2.00      2.00      2.00     -0.00     -0.00      1.00     -0.00      1.00
J2      -0.00     -0.00      2.00      1.00     -0.00      0.00     -1.00     -0.00     -0.00     -1.00
J4       6.00       .30      1.00      1.50      2.00      3.00      0.00     -0.00     -0.00     -0.00
J5       2.00      1.00      9.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00

RL       1.00 100000.00     -0.00   50000.00 100000.00     -0.00     -0.00     -0.00     -0.00     -0.00
RO       1.00      4.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RS       2.00  50000.00 100000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RO       2.00 200000.00 200000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00

CP       1.00   6000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
ID CP 1                                         -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RT       1.00      2.00       .20       .30      6.00     -0.00     -0.00     -0.00     -0.00     -0.00

CP       2.00  21000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
ID CP 2                                         -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RT       2.00      4.00       .20       .30      6.00     -0.00     -0.00     -0.00     -0.00     -0.00

RL       3.00 100000.00     -0.00   50000.00 100000.00     -0.00     -0.00     -0.00     -0.00     -0.00
RO       1.00      4.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RS       2.00  50000.00 100000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RO       2.00 200000.00 200000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00

CP       3.00  12000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
ID CP 3                                         -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RT       3.00      4.00       .20       .30      6.00     -0.00     -0.00     -0.00     -0.00     -0.00

CP       4.00  35000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
ID CP 4                                         -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RT       4.00      5.00       .20       .30      6.00     -0.00     -0.00     -0.00     -0.00     -0.00
DA       1.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
DF      17.00      1.00       .90       .80       .70       .60       .50       .40       .30       .25
DF        .20       .15       .10       .05       .02       .01       .01       .00     -0.00     -0.00
DQ      17.00  28800.00  35000.00  42000.00  50500.00  60500.00  73000.00  90000.00 110000.00 130000.00
DQ  150000.00 180000.00 230000.00 323000.00 490000.00 640000.00 840000.00 1000000.00    -0.00     -0.00
DC       1.00      0.00      0.00    180.00    380.00    500.00    630.00    900.00   1250.00   1500.00
DC    1930.00   2660.00   5000.00   9900.00  12280.00  13350.00  14150.00  14600.00     -0.00     -0.00

CP       5.00  37000.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
ID CP 5                                         -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
RT       5.00      0.00      0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00
ED      -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00     -0.00

     NRFS=     2  NCPT=     5  NCPTR=     =0

IN     1  6 JUNE     1000.0    2000.0    3000.0   18000.0   37000.0   42000.0   50000.0   27000.0   20000.0   13000.0
                     5000.0    4000.0    3000.0    2000.0    1000.0    1000.0    1000.0    1000.0
                                                                                                   SUM=      231000
IN     2  6 JUNE     2000.0    3000.0    4000.0    6000.0   20000.0   57000.0  100000.0   90000.0   70000.0   50000.0
                    37000.0   24000.0   24000.0   15000.0    9000.0    3000.0    2000.0    1500.0
```

Dummy Reservoir

Dummy Reservoir

												SUM=	517500
IN	3	6 JUNE	3000,0	6000,0	27000,0	60000,0	105000,0	78000,0	60000,0	45000,0	33000,0	24000,0	
			18000,0	12000,0	12000,0	9000,0	6000,0	3000,0	2000,0	1000,0			
												SUM=	504000
IN	4	6 JUNE	2000,0	4000,0	19000,0	13000,0	10000,0	7000,0	4000,0	1000,0	1000,0	4000,0	
			10000,0	25000,0	13000,0	7000,0	4000,0	2000,0	1000,0	500,0			
												SUM=	127500
IN	5	6 JUNE	1000,0	2000,0	9000,0	6000,0	5000,0	3000,0	2000,0	500,0	500,0	2000,0	
			5000,0	12000,0	6000,0	4000,0	2000,0	1000,0	500,0	200,0			
												SUM=	61700
EJ	-0		-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0			

Page 3
Natural Condition

Page 8
Natural Cond.

SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850.00	3850.00	3850.00	3850.00	.03	2.00	0.00
3	8400.00	8400.00	8400.00	8400.00	.03	2.00	0.00

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	Q SPACE	Q BY US	FLOOD BY
2	12474.98	12474.98	12474.98	8525.02	0.00	0.00
4	23035.43	23035.43	23035.43	11964.57	0.00	0.00
5	24083.97	24083.97	24083.97	12916.03	0.00	0.00

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRD= 1 NFLCUN= 6
IFLRD = 1 IFLCUN= 2
FLOWS MULTIPLIED BY 1.00

****

**** LOC 1 CP 1 SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 6,YEAR=19 5,

SERVING 1

PER	CUM LOCAL Q								
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER	NATURAL FLOW									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER	INFLOW									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER	OUTFLOW									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

```
PER       CASE=LOC,TYP

  1    .03    .03    .03    .03    .03    .03    .03    .03    .03    .03
 11    .03    .03    .03    .03    .03    .03    .03    .03
                                                                 AVG=      .030  MAX=      .030
                                                                                 MIN=      .030
PER       LEVEL

  1  2.000  2.000  2.000  2.000  2.000  2.000  2.000  2.000  2.000  2.000
 11  2.000  2.000  2.000  2.000  2.000  2.000  2.000  2.000
                                                                 AVG=     2.000  MAX=     2.000
                                                                                 MIN=     2.000
PER       EOP STORAGE

  1      0      0      0      0      0      0      0      0      0      0
 11      0      0      0      0      0      0      0      0
                                                                 AVG=     0.000  MAX=     0.000
                                                                                 MIN=     0.000
**********************************************************************************************
**** LOC     2  CP 2                        SERVED BY     =1

PER       CUM LOCAL Q

  1   3000   4167   6028  11338  39056  91843 142140 134857  98809  70302
 11  49884  30147  28191  18032  11005   4168   3028   2505
                                                                 AVG= 41583.282  MAX= 142140.854
                                                                                 MIN=   2504.654
PER       NATURAL FLOW

  1   3000   4167   6028  11338  39056  91843 142140 134857  98809  70302
 11  49884  30147  28191  18032  11005   4168   3028   2505
                                                                 AVG= 41583.282  MAX= 142140.854
                                                                                 MIN=   2504.654
PER       REGULATED FLOW

  1   3000   4167   6028  11338  39056  91843 142140 134857  98809  70302
 11  49884  30147  28191  18032  11005   4168   3028   2505
                                                                 AVG= 41583.282  MAX= 142140.854
                                                                                 MIN=   2504.654
PER       Q SPACE AVAIL.

  1  18000  16833  14972   9662 -18056 -70843-121140-113857 -77809 -49302
 11 -28884  -9147  -7191   2968   9995  16832  17972  18495
                                                                 AVG=-20583.282  MAX=  18495.346
                                                                                 MIN=-121140.854
PER       Q BY US RES,DIVS

  1      0      0      0      0      0      0      0      0      0      0
 11      0      0      0      0      0      0      0      0
                                                                 AVG=     0.000  MAX=     0.000
                                                                                 MIN=     0.000
PER       FLOOD BY RES

  1      0      0      0      0      0      0      0      0      0      0
 11      0      0      0      0      0      0      0      0
                                                                 AVG=     0.000  MAX=     0.000
```

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```
                                                                                              MIN=      0.000
*************************************************************************************************
**** LOC    3  CP 3                               SERVED BY    2                                    Pagb Natural Load
                                                                                        STARTING TIME=       1
                                                                                        HOUR=12,DAY= 0,MON= 0,YEAR=19 0.
                                        SERVING      2
PER        CUM LOCAL Q

    1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
   11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                        AVG=  28000.000  MAX= 105000.000
                                                                                                         MIN=   1000.000
PER        NATURAL FLOW

    1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
   11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                        AVG=  28000.000  MAX= 105000.000
                                                                                                         MIN=   1000.000
PER        INFLOW

    1    3000    6000   27000   .0000  105000   78000   60000   45000   33000   24000
   11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                        AVG=  28000.000  MAX= 105000.000
                                                                                                         MIN=   1000.000
PER.       OUTFLOW

    1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
   11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                        IVG=  28000.000  MAX= 105000.000
                                                                                                         MIN=   1000.000
PER        CASE=LOC,TYP

    1     .03     .03     .03     .03     .03     .03     .03     .03     .03     .03
   11     .03     .03     .03     .03     .03     .03     .03     .03

                                                                                        AVG=       .030  MAX=       .030
                                                                                                         MIN=       .030
PER        LEVEL

    1   2.000   2.000   2.000   2.000   2.000   2.000   2.000   2.000   2.000   2.000
   11   2.000   2.000   2.000   2.000   2.000   2.000   2.000   2.000

                                                                                        AVG=      2.000  MAX=      2.000
                                                                                                         MIN=      2.000
PER        EOP STORAGE

    1       0       0       0       0       0       0       0       0       0       0
   11       0       0       0       0       0       0       0       0

                                                                                        AVG=      0.000  MAX=      0.000
                                                                                                         MIN=      0.000
*************************************************************************************************
**** LOC    4  CP 4                               SERVED BY   =1    =2

PER        CUM LOCAL Q

    1    8000   10694   32398   49141   87592  144277  173798  194036  175045  136997
   11  106281   93527   59185   45997   31395   19091    9465    5847
```

AVG= 76784,776 MAX= 194036,091
MIN= 5846,858

PER NATURAL FLOW

PER										
1	8000	10698	32398	49141	87592	144277	173798	194036	175045	136597
11	106281	93327	59185	45997	31355	19091	9465	5847		

AVG= 76784,776 MAX= 194036,091
MIN= 5846,858

PER REGULATED FLOW

PER										
1	8000	10698	32398	49141	87592	144277	173798	194036	175045	136597
11	106281	93327	59185	45997	31355	19091	9465	5847		

AVG= 76784,776 MAX= 194036,091
MIN= 5846,858

PER Q SPACE AVAIL.

PER										
1	27000	24300	2602	-14141	-52592	-109277	-138798	-159036	-140045	-101597
11	-71281	-58327	-24185	-10997	3645	15909	25535	29153		

AVG= -41784,776 MAX= 29153,142
MIN=-159036,091

PER Q BY US RES,DIVS

PER										
1	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0		

AVG= 0,000 MAX= 0,000
MIN= 0,000

PER FLOOD BY RES

PER										
1	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0		

A/G= 0,000 MAX= 0,000
MIN= 0,000

****

**** LOC 5 CP 5 SERVED BY -1 -2

PER CUM LOCAL Q

PER										
1	9000	10449	22937	38112	57711	94226	142355	172097	187631	172652
11	142220	121279	96295	66172	48252	32794	20104	10752		

AVG= 80279,898 MAX= 187631,160
MIN= 9000,000

PER NATURAL FLOW

PER										
1	9000	10449	22937	38112	57711	94226	142355	172097	187631	172652
11	142220	121279	96295	66172	48252	32794	20104	10752		

AVG= 80279,898 MAX= 187631,160
MIN= 9000,000

PER REGULATED FLOW

PER										
1	9000	10449	22937	38112	57711	94226	142355	172097	187631	172652
11	142220	121279	96295	66172	48252	32794	20104	10752		

AVG= 80279,898 MAX= 187631,160
MIN= 9000,000

PER Q SPACE AVAIL.

PER										
1	28000	26551	14063	-1112	-20711	-57226	-105355	-135097	-150631	-135652
11	-105220	-84279	-59295	-29172	-11252	4206	16896	26248		

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AVG= -43279.898 MAX= 28000.000 Page 8
MIN=-150631.100 Natural Cond.

PER 0 BY US RES,DIVS

1	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0		

AVG= 0.000 MAX= 0.000
MIN= 0.000

PER FLOOD BY RES

1	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0		

AVG= 0.000 MAX= 0.000
MIN= 0.000

****

CUM TIME= 1

RES NO=	1	3
INFLOW	1000	3000
OUTFLOW	1000	3000
EOP STOR	0	0
CASE=	.03	.03
LEVEL	2.000	2.000
EQ LEVEL	2.000	2.000

CUM TIME= 2

RES NO=	1	3
INFLOW	2000	6000
OUTFLOW	2000	6000
EOP STOR	0	0
CASE=	.03	.03
LEVEL	2.000	2.000
EQ LEVEL	2.000	2.000

CUM TIME= 3

RES NO=	1	3
INFLOW	3000	27000
OUTFLOW	3000	27000
EOP STOR	0	0
CASE=	.03	.03
LEVEL	2.000	2.000
EQ LEVEL	2.000	2.000

CUM TIME= 4

RES NO=	1	3
INFLOW	18000	60000
OUTFLOW	18000	60000
EOP STOR	0	0
CASE=	.03	.03
LEVEL	2.000	2.000
EQ LEVEL	2.000	2.000

FALL RIVER BASIN *** NATURAL (UNREGULATED) CONDITION ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES
FLOOD SUMMARY-EACH FLOOD COPY= 1

***** FLOOD NUMBER 1 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REG
LOC 2 CP 2	1,007	42642 *	1,007	42642 *	1,007	42642 *	0 *	0,00	0,00
LOC 4 CP 4	1,008	58211 *	1,008	58211 *	1,008	58211 *	0 *	0,00	0,00
LOC 5 CP 5	1,009	56289 *	1,009	56289 *	1,009	56289 *	0 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 CP 1	1,018	0	2,000 *	1,001	0	2,000 *	1,007	15000	6000	0
LOC 3 CP 3	1,018	0	2,000 *	1,001	0	2,000 *	1,005	31500	12000	0

MIN SYSTEM STG= 0 MAX SYSTEM STG= 0

***** FLOOD NUMBER 2 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REG
LOC 2 CP 2	2,007	142140 *	2,007	142140 *	2,007	142140 *	0 *	0,00	0,00
LOC 4 CP 4	2,008	194036 *	2,008	194036 *	2,008	194036 *	0 *	0,00	0,00
LOC 5 CP 5	2,009	187631 *	2,009	187631 *	2,009	187631 *	0 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 CP 1	2,018	0	2,000 *	2,001	0	2,000 *	2,007	50000	6000	0
LOC 3 CP 3	2,018	0	2,000 *	2,001	0	2,000 *	2,005	105000	12000	0

MIN SYSTEM STG= 0 MAX SYSTEM STG= 0

***** FLOOD NUMBER 3 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REG
LOC 2 CP 2	3,007	213211 *	3,007	213211 *	3,007	213211 *	0 *	0,00	0,00
LOC 4 CP 4	3,008	291054 *	3,008	291054 *	3,008	291054 *	0 *	0,00	0,00
LOC 5 CP 5	3,009	281447 *	3,009	281447 *	3,009	281447 *	0 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 CP 1	3,018	0	2,000 *	3,001	0	2,000 *	3,007	75000	6000	0

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```
LOC   3  CP 3            3,018     0    2,000 *  3,001      0    2,000 *  3,005  157500    12000        0
                 MIN SYSTEM STG=       0   MAX SYSTEM STG=      0

                          ***** FLOOD NUMBER  4 *****

                                                                           STARTING TIME      1
                                                                                      SHORTAGE INDEX
                         FLD,PER  MAX REG Q *   FLD,PER  MAX NAT Q *   FLD,PER  MAX LOC Q * Q BY RES *  DES     REG
LOC   2  CP 2            4,007     284281 *     4,007     284281 *     4,007     284281 *        0 *   0,00    0,00
LOC   4  CP 4            4,008     380072 *     4,008     380072 *     4,008     380072 *        0 *   0,00    0,00
LOC   5  CP 5            4,009     375262 *     4,009     375262 *     4,009     375262 *        0 *   0,00    0,00
        RESERVOIRS       FLD,PER  MIN STG MIN LEVEL * FLD,PER  MAX STG MAX LEVEL * FLD,PER  MAX REL  CHAN CAP   STOR1
LOC   1  CP 1            4,018     0    2,000 *  4,001      0    2,000 *  4,007  100000     6000        0
LOC   3  CP 3            4,018     0    2,000 *  4,001      0    2,000 *  4,005  210000    12000        0
                 MIN SYSTEM STG=       0   MAX SYSTEM STG=      0

                          ***** FLOOD NUMBER  5 *****

                                                                           STARTING TIME      1
                                                                                      SHORTAGE INDEX
                         FLD,PER  MAX REG Q *   FLD,PER  MAX NAT Q *   FLD,PER  MAX LOC Q * Q BY RES *  DES     REG
LOC   2  CP 2            5,007     426421 *     5,007     426421 *     5,007     426421 *        0 *   0,00    0,00
LOC   4  CP 4            5,008     582108 *     5,008     582108 *     5,008     582108 *        0 *   0,00    0,00
LOC   5  CP 5            5,009     562893 *     5,009     562893 *     5,009     562893 *        0 *   0,00    0,00
        RESERVOIRS       FLD,PER  MIN STG MIN LEVEL * FLD,PER  MAX STG MAX LEVEL * FLD,PER  MAX REL  CHAN CAP   STOR1
LOC   1  CP 1            5,018     0    2,000 *  5,001      0    2,000 *  5,007  150000     6000        0
LOC   3  CP 3            5,018     0    2,000 *  5,001      0    2,000 *  5,005  315000    12000        0
                 MIN SYSTEM STG=       0   MAX SYSTEM STG=      0

                          ***** FLOOD NUMBER  6 *****

                                                                           STARTING TIME      1
                                                                                      SHORTAGE INDEX
                         FLD,PER  MAX REG Q *   FLD,PER  MAX NAT Q *   FLD,PER  MAX LOC Q * Q BY RES *  DES     REG
LOC   2  CP 2            6,007     568562 *     6,007     568562 *     6,007     568562 *        0 *   0,00    0,00
LOC   4  CP 4            6,008     776144 *     6,008     776144 *     6,008     776144 *        0 *   0,00    0,00
LOC   5  CP 5            6,009     750525 *     6,009     750525 *     6,009     750525 *        0 *   0,00    0,00
        RESERVOIRS       FLD,PER  MIN STG MIN LEVEL * FLD,PER  MAX STG MAX LEVEL * FLD,PER  MAX REL  CHAN CAP   STOR1
LOC   1  CP 1            6,018     0    2,000 *  6,001      0    2,000 *  6,007  200000     6000        0
LOC   3  CP 3            6,018     0    2,000 *  6,001      0    2,000 *  6,005  420000    12000        0
                 MIN SYSTEM STG=       0   MAX SYSTEM STG=      0
```

EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES

	SUM	TYPE 1
BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.034	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776144	.007	.010	138.03	138.03	
	BASE COND DAMAGES			1721.30	1721.30	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.034	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776144	.007	.010	138.03	138.03	
	MODIFIED DAMAGES			1721.30	1721.30	
	DAMAGE REDUCTION			.00	.00	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.034	.025	265.87	265.87	

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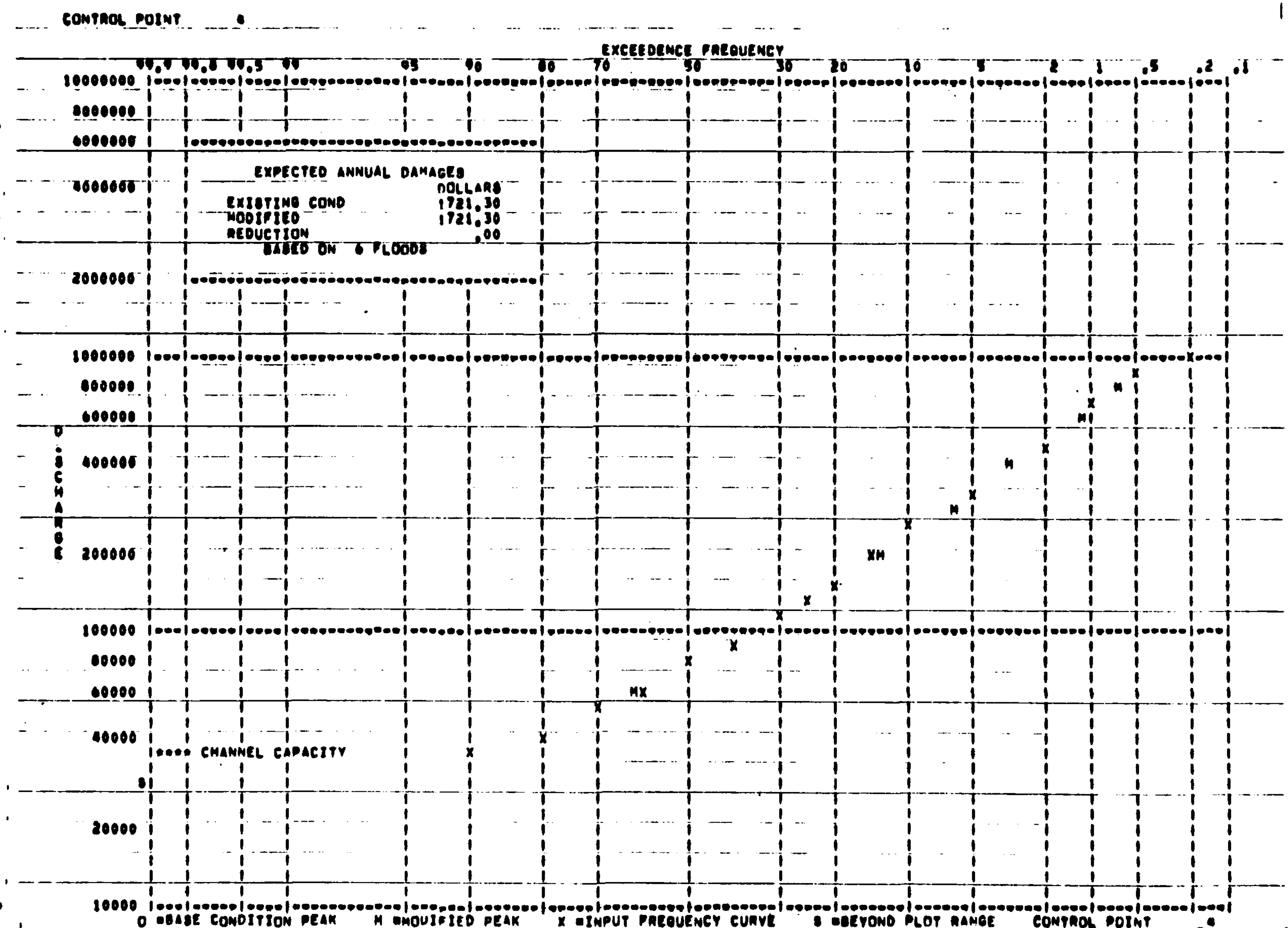
5	502100	.013	.014	173.38	173.38
6	776144	.007	.010	130.03	130.03
DAMAGES W/ TOTAL CONTROL AT PROJECTS				1721.30	1721.30
REDUCTION POSSIBLE W/ TOTAL CONTROL				.00	.00
RESIDUAL DAMAGES				0.00	0.00



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SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES			DAMAGE REDUCTION		
	BASE (EXIST) CONDITION	MODIFIED CONDITIONS	UNCONTROL LOCAL COND	MODIFIED CONDITIONS	TOTAL CONTROL AT PROJECTS	RESIDUAL
8	1721.30	1721.30	1721.30	.00	.00	0.00
TOTAL	1721.30	1721.30	1721.30	.00	.00	0.00

```
HEC-5C-VARIABLE OUTPUT MAR.1975
RES.= 35 CPTS.= 75 PERS.=100

T1 FALL RIVER BASIN    ***   EXISTING SYSTEM (RESERVOIRS A AND C )   ***
T2 TRAINING DOCUMENT NO. 7
T3 FLOOD RATIOS .3  1.0  1.5  2.0  3.0  4.0  USED TO COMPUTE ANNUAL DAMAGES
J1        18.00       6.00       4.00       2.00       3.00      -0.00      -0.00       1.00      -0.00       1.00
J2        -0.00       1.10       2.00       1.00      -0.00       0.00      -1.00      -0.00      -0.00      -1.00
J8         6.00        .30       1.00       1.50       2.00       3.00       4.00      -0.00      -0.00      -0.00

RL         1.00   50000.00      -0.00       0.00   50000.00  150832.00  200000.00      -0.00      -0.00      -0.00
RO         1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RS         6.00       0.00   50000.00   70000.00  100000.00  150832.00  200000.00      -0.00      -0.00      -0.00
RQ         6.00    5000.00    6000.00    7000.00    8000.00  100000.00  200000.00      -0.00      -0.00      -0.00

CP         1.00    6000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID RESERVOIR A (CP 1)                                -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT         1.00       2.00        .25        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

CP         2.00   21000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 2                                              -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT         2.00       4.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

RL         3.00  100000.00      -0.00       0.00  100000.00  755408.00 1000000.00     -0.00      -0.00      -0.00
RO         1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RS         7.00       0.00  100000.00  200000.00  400000.00  700000.00  800000.00 1000000.00     -0.00      -0.00
RQ         7.00   10000.00   12000.00   18000.00   30000.00   80000.00  150000.00  500000.00      -0.00      -0.00

CP         3.00   12000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID RESERVOIR C (CP 3)                                -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT         3.00       4.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

CP         4.00   35000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 4                                              -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT         4.00       5.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00
DA         1.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DF        17.00       1.00        .90        .80        .70        .60        .50        .40        .30        .25
DF          .20        .15        .10        .05        .02        .01        .01        .00      -0.00      -0.00
DISCHARGE     DQ        17.00   28800.00   35000.00   42000.00   50500.00   60500.00   73000.00   90000.00  114000.00  130000.00
DAMAGE        DQ    150000.00  180000.00  230000.00  323000.00  490000.00  680000.00  840000.00 1000000.00      -0.00      -0.00
FUNCTION      DC         1.00       0.00       0.00     180.00     380.00     500.00     630.00     900.00    1250.00    1500.00
EXISTING      DC      1930.00    2660.00    5000.00    9900.00   12280.00   13350.00   14150.00   14600.00      -0.00      -0.00
SYSTEM

CP         5.00   37000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 5                                              -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT         5.00       0.00       0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ED        -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00

    NRES=     2 NCPT=     5 NCPTR=     -0

IN     1  6 JUNE    1000.0    2000.0    3000.0   18000.0   37000.0   42000.0   50000.0   27000.0   20000.0   13000.0
                    5000.0    4000.0    3000.0    2000.0    1000.0    1000.0    1000.0    1000.0
                                                                                                    SUM=     231000
IN     2  6 JUNE    2000.0    3000.0    4000.0    6000.0   20000.0   57000.0  100000.0   90000.0   70000.0   50000.0
                   37000.0   24000.0   24000.0   15000.0    9000.0    3000.0    2000.0    1500.0
                                                                                                    SUM=     517500
IN     3  6 JUNE    3000.0    6000.0   27000.0   60000.0  105000.0   78000.0   68000.0   45000.0   33000.0   24000.0
                   18000.0   12000.0   12000.0    9000.0    6000.0    3000.0    2000.0    1000.0
                                                                                                    SUM=     504000
```

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```
IN    4  6 JUNE    2000,0      [illegible]   19000,0   13000,0   10000,0    7000,0    4000,0    1000,0    1000,0    4000,0
                  10000,0     25000,0   13000,0    7000,0    4000,0    2000,0    1000,0     500,0
                                                                                                      SUM=      127500
IN    5  6 JUNE    1000,0      2000,0    9000,0    6000,0    5000,0    3000,0    2000,0     500,0     500,0    2000,0
                   5000,0     12000,0    6000,0    4000,0    2000,0    1000,0     500,0     200,0
                                                                                                      SUM=       61700
EJ   =0              =0,0        =0,0      =0,0      =0,0      =0,0      =0,0      =0,0      =0,0
```

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SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850.00	3850.00	3850.00	3850.00	.90	2.07	57494.67
3	8400.00	8400.00	8400.00	7450.62	1.12	2.03	122385.98

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	0 SPACE	0 BY US	FLOOD BY
2	8625.00	12474.98	12320.87	8671.13	3703.87	476.19
4	10755.92	23035.43	21005.66	13994.34	10249.74	0.00
5	11795.97	24083.97	21119.00	15661.00	9323.04	0.00

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRD= 1 NFLCUN= 6
IFLRD = 1 IFLCUN= 2
FLOWS MULTIPLIED BY 1.00

****

**** LOC 1 RESERVOIR A (CP 1) SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 0,YEAR=19 0,

PER CUM LOCAL Q SERVING 1 4

PER										
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

PER NATURAL FLOW — AVG= 12833.333 MAX= 50000.000 MIN= 1000.000

PER										
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

PER INFLOW — AVG= 12833.333 MAX= 50000.000 MIN= 1000.000

PER										
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

PER OUTFLOW — AVG= 12833.333 MAX= 50000.000 MIN= 1000.000

PER										
1	1000	2000	3000	0	0	0	0	0	0	3658
11	5000	4000	3000	2000	6000	6000	6000	6000		

PER CASE=LOC.TYP — AVG= 2647.691 MAX= 6000.000 MIN= 0.000

PER										
1	.03	.03	.03	4.02	4.01	4.00	4.00	4.00	4.00	.04

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11	.04	.04	.04	.04	.01	.01	.01	.01

AVG= 1,353 MAX= 4,020
MIN= ,010

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PER LEVEL

PER										
1	2,000	2,000	2,000	2,089	2,270	2,477	2,723	2,856	2,954	3,000
11	3,000	3,000	3,000	3,000	2,975	2,951	2,926	2,902		

AVG= 2,673 MAX= 3,000
MIN= 2,000

PER EOP STORAGE

PER										
1	50000	50000	50000	58926	77273	98100	122894	136282	146200	150832
11	150832	150832	150832	150832	148353	145873	143394	140914		

AVG= 117909,368 MAX= 150832,000
MIN= 50000,000

****

**** LOC 2 CP 2 SERVED BY -1

PER CUM LOCAL Q

PER										
1	2000	3000	4000	6000	20000	57000	100000	90000	70000	50000
11	37000	24000	24000	15000	9000	3000	2000	1500		

AVG= 28750,000 MAX= 100000,000
MIN= 1500,000

PER NATURAL FLOW

PER										
1	3000	4167	6028	11338	39056	91643	142140	134857	98809	70302
11	49884	30147	28191	18032	11005	4168	3028	2505		

AVG= 41583,282 MAX= 142140,458
MIN= 2504,658

PER REGULATED FLOW

PER										
1	3000	4167	6028	8338	20390	57065	100011	90002	70000	50610
11	40374	28562	27927	17988	11831	8472	7912	7485		

AVG= 31120,076 MAX= 100010,824
MIN= 3000,000

PER Q SPACE AVAIL.

PER										
1	18000	16833	14972	12662	610	-36065	-79011	-69002	-49000	-29610
11	-19374	-7562	-6927	3012	9169	12528	13088	13515		

AVG= -10120,076 MAX= 18000,000
MIN= -79010,824

PER Q BY US RES,DIVS

PER										
1	1000	1167	2028	2338	390	65	11	2	0	610
11	3374	4562	3927	2988	2831	5472	5912	5985		

AVG= 2370,076 MAX= 5985,330
MIN= ,381

PER FLOOD BY RES

PER										
1	0	0	0	0	0	65	11	2	0	610
11	3374	4562	3927	0	0	0	0	0		

AVG= 697,275 MAX= 4562,320
MIN= 0,000

****

```
**** LOC     3  RESERVOIR C (CP 3)              SERVED BY     2
                                                                                  STARTING TIME=        1
                                         SERVING        2     4                   HOUR=12,DAY= 6,MON= 0,YEAR=19 0,
PER        CUM LOCAL Q

   1   3000   6000  27000  60000 105000  78000  60000  45000  33000  24000
  11  18000  12000  12000   9000   6000   3000   2000   1000

                                                                                  AVG=  28000,000  MAX= 105000,000
                                                                                                   MIN=   1000,000
PER        NATURAL FLOW

   1   3000   6000  27000  60000 105000  78000  60000  45000  33000  24000
  11  18000  12000  12000   9000   6000   3000   2000   1000

                                                                                  AVG=  28000,000  MAX= 105000,000
                                                                                                   MIN=   1000,000
PER        INFLOW

   1   3000   6000  27000  60000 105000  78000  60000  45000  33000  24000
  11  18000  12000  12000   9000   6000   3000   2000   1000

                                                                                  AVG=  28000,000  MAX= 105000,000
                                                                                                   MIN=   1000,000
PER        OUTFLOW

   1   3000   6000  12000      0      0      0      0      0      0      0
  11      0      0      0      0  12000  12000  12000  12000

                                                                                  AVG=   3833,333  MAX=  12000,000
                                                                                                   MIN=      0,000
PER        CASE=LOC,TYP

   1    ,03    ,03    ,01   4,02   4,01   4,00   4,00   4,00   4,00   4,00
  11   4,00   4,00   4,00   4,00    ,01    ,01    ,01    ,01

                                                                                  AVG=      2,452  MAX=      4,020
                                                                                                   MIN=       ,010
PER        LEVEL

   1  2,000  2,000  2,011  2,057  2,130  2,195  2,241  2,275  2,300  2,310
  11  2,331  2,340  2,350  2,356  2,352  2,345  2,337  2,329

                                                                                  AVG=      2,237  MAX=      2,356
                                                                                                   MIN=      2,000
PER        EOP STORAGE

   1 100000 100000 107430 137191 189257 227936 257688 280003 296366 308267
  11 317193 323184 329094 333557 330582 326119 321160 315706

                                                                                  AVG= 255594,556  MAX= 333557,125
                                                                                                   MIN= 100000,000
*********************************************************************************************************************
**** LOC     4  CP 4                            SERVED BY     1     2

PER        CUM LOCAL Q

   1   4000   6167  22028  17171  18029  31171  62695  92849  87908  73885
  11  61081  62180  39197  29866  19311  11052   4842   2728

                                                                                  AVG=  35853,070  MAX=  92849,206
                                                                                                   MIN=   2723,662
PER        NATURAL FLOW
```

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PER										
1	8000	10694	32398	4[illegible]141	87592	144277	173798	194036	175045	136597
11	100201	93327	59185	45907	31355	19091	9465	5847		

AVG= 76784,776 MAX= 194036,091 MIN= 5846,858

PER REGULATED FLOW

PER										
1	8000	10694	29898	20225	21494	32020	62082	92488	87916	73588
11	62067	65356	63422	33686	24411	24701	21750	20481		

A'G= 41282,055 MAX= 92487,881 MIN= 8000,000

PER Q SPACE AVAIL.

PER										
1	27000	24306	5102	6775	13506	2980	-27082	-57480	-52916	-30580
11	-27067	-30354	-8422	1314	10509	10299	13250	14519		

AVG= -6282,055 MAX= 27000,000 MIN= -57487,881

PER Q BY US RES,DIVS

PER										
1	4000	4528	7870	11053	3466	848	186	39	8	103
11	986	3174	4225	3820	5100	13650	16908	17757		

AVG= 5420,984 MAX= 17756,907 MIN= 7,688

PER FLOOD BY RES

PER										
1	0	0	0	0	0	0	186	39	8	103
11	986	3174	4225	0	0	0	0	0		

AVG= 484,498 MAX= 4225,056 MIN= 0,000

****

**** LOC 5 CP 5 SERVED BY #1 #2

PER CUM LOCAL Q

PER										
1	5000	6361	17509	24965	22613	23150	36588	63470	87279	87316
11	78389	75315	64539	44865	31940	20706	11959	5792		

AVG= 39319,888 MAX= 87316,106 MIN= 5000,000

PER NATURAL FLOW

PER										
1	9000	10449	22937	38112	57711	94226	142355	172097	187631	172652
11	142220	121279	96295	66172	48252	32798	20104	10752		

AVG= 80279,898 MAX= 187631,160 MIN= 9000,000

PER REGULATED FLOW

PER										
1	9000	10449	22521	32890	31880	27186	37851	63811	87363	87392
11	78628	76542	67563	48823	35907	27057	24936	22186		

AVG= 43999,739 MAX= 87363,008 MIN= 9000,000

PER Q SPACE AVAIL.

PER										
1	28000	26551	14479	4110	5120	9854	-851	-26811	-50363	-50352
11	-41628	-39542	-30563	-11823	1003	9943	12064	14814		

AVG= -6999,739 MAX= 28000,000 MIN= -50363,008

```
PER       Q BY US RES,DIVS

  1    4680    4688    5012    7924    9267    3996    1263     381     84     36
 11     239    1226    3025    3957    4056    6351   12976   16394

                                                        AVG=  4679,852  MAX=  16394,328
                                                                        MIN=     36,288
PER       FLOOD BY RES

  1       0       0       0       0       0       0     851     381     84     36
 11     239    1226    3025    3957       0       0       0       0

                                                        AVG=   542,212  MAX=   3957,493
                                                                        MIN=      0,000
****************************************************************************************

             CUM TIME=      1

RES NO=          1        3
INFLOW        1000     3000
OUTFLOW       1000     3000
EOP STOR     50000   100000
CASE=          ,03      ,03
LEVEL        2,000    2,000
EQ LEVEL     2,000    2,000

             CUM TIME=      2

RES NO=          1        3
INFLOW        2000     6000
OUTFLOW       2000     6000
EOP STOR     50000   100000
CASE=          ,03      ,03
LEVEL        2,000   .2,000
EQ LEVEL     2,000    2,000

             CUM TIME=      3

RES NO=          1        3
INFLOW        3000    27000
OUTFLOW       3000    12000
EOP STOR     50000   107438
CASE=          ,03      ,01
LEVEL        2,000    2,011
EQ LEVEL     2,000    2,011

             CUM TIME=      4

RES NO=          1        3
INFLOW       18000    60000
OUTFLOW          0        0
EOP STOR     58926   137191
CASE=         4,02     4,02
LEVEL        2,089    2,057
EQ LEVEL     2,089    2,057

             CUM TIME=      5
```

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FALL RIVER BASIN *** EXISTING SYSTEM (RESERVOIRS A AND C) ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES
FLOOD SUMMARY-EACH FLOOD COPYS 1

***** FLOOD NUMBER 1 *****

STARTING TIME 1

			FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	1.007	34777 *	1.007	42642 *	1.007	30000 *	4777 *	0.00	0.00
LOC	4	CP 4	1.012	33134 *	1.008	58211 *	1.008	27735 *	5400 *	0.00	0.00
LOC	5	CP 5	1.012	33586 *	1.009	56289 *	1.010	26195 *	7391 *	0.00	0.00

		RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	1.018	50000	2.000 *	1.008	67393	2.173 *	1.005	6000	6000	50000
LOC	3	RESERVOIR C (CP 3)	1.003	100000	2.000 *	1.010	140755	2.062 *	1.004	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 208148

***** FLOOD NUMBER 2 *****

STARTING TIME 1

			FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	2.007	100011 *	2.007	142140 *	2.007	100000 *	11 *	0.00	0.00
LOC	4	CP 4	2.008	92488 *	2.008	194036 *	2.008	92449 *	39 *	0.00	0.00
LOC	5	CP 5	2.009	87363 *	2.009	187631 *	2.010	87316 *	47 *	0.00	0.00

		RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	2.003	50000	2.000 *	2.011	150832	3.000 *	2.015	6000	6000	50000
LOC	3	RESERVOIR C (CP 3)	2.002	100000	2.000 *	2.014	333557	2.356 *	2.003	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 484389

***** FLOOD NUMBER 3 *****

STARTING TIME 1

			FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	3.007	157221 *	3.007	213211 *	3.007	150000 *	7221 *	0.00	0.00
LOC	4	CP 4	3.009	150695 *	3.008	291054 *	3.008	138674 *	12022 *	0.00	0.00
LOC	5	CP 5	3.010	150348 *	3.009	281447 *	3.010	130974 *	19374 *	0.00	0.00

		RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	3.001	50744	2.007 *	3.007	150832	3.000 *	3.008	40499	6000	50000
LOC	3	RESERVOIR C (CP 3)	3.001	102231	2.003 *	3.015	470418	2.565 *	3.010	12000	12000	100000

MIN SYSTEM STG= 152974 MAX SYSTEM STG= 621250

***** FLOOD NUMBER 4 *****

STARTING TIME 1

		FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q * Q BY RES *		SHORTAGE INDEX DES	REG
LOC	2 CP 2	4,008	252767 *	4,007	288281 *	4,007	200000 *	52767 *	0,00	0,00
LOC	4 CP 4	4,009	237896 *	4,008	388072 *	4,008	184898 *	52998 *	0,00	0,00
LOC	5 CP 5	4,010	229892 *	4,009	375262 *	4,010	174632 *	55259 *	0,00	0,00

	RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	4,001	50092	2,010 *	4,007	150832	3,000 *	4,007	90658	6000	50000
LOC	3 RESERVOIR C (CP 3)	4,001	102975	2,005 *	4,015	893891	2,758 *	4,010	12000	12000	100000

MIN SYSTEM STG= 153966 MAX SYSTEM STG= 744723

***** FLOOD NUMBER 5 *****

STARTING TIME 1

		FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q * Q BY RES *		SHORTAGE INDEX DES	REG
LOC	2 CP 2	5,008	383382 *	5,007	428421 *	5,007	300000 *	83382 *	0,00	0,00
LOC	4 CP 4	5,009	372066 *	5,008	582108 *	5,008	277348 *	94718 *	0,00	0,00
LOC	5 CP 5	5,010	365070 *	5,009	562893 *	5,010	261948 *	103121 *	0,00	0,00

	RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	5,001	51488	2,015 *	5,007	168236	3,354 *	5,007	120542	6000	50000
LOC	3 RESERVOIR C (CP 3)	5,001	104463	2,007 *	5,011	755408	3,000 *	5,012	35999	12000	100000

MIN SYSTEM STG= 155949 MAX SYSTEM STG= 923644

***** FLOOD NUMBER 6 *****

STARTING TIME 1

		FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q * Q BY RES *		SHORTAGE INDEX DES	REG
LOC	2 CP 2	6,007	516031 *	6,007	568562 *	6,007	400000 *	116031 *	0,00	0,00
LOC	4 CP 4	6,009	612533 *	6,008	776144 *	6,008	369797 *	242736 *	0,00	0,00
LOC	5 CP 5	6,010	594538 *	6,009	750525 *	6,010	349264 *	245274 *	0,00	0,00

	RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	6,001	51983	2,020 *	6,007	191183	3,821 *	6,007	163829	6000	50000
LOC	3 RESERVOIR C (CP 3)	6,001	105956	2,000 *	6,006	781273	3,106 *	6,009	136168	12000	100000

MIN SYSTEM STG= 157933 MAX SYSTEM STG= 972456

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES

	SUM	TYPE 1
BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.034	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776144	.007	.010	138.03	138.03	
	BASE COND DAMAGES			1721.30	1721.30	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	33134	.621	.623	33.98	33.98	
2	92488	.134	.279	177.15	177.15	
3	150695	.062	.050	88.69	88.69	
4	237896	.034	.025	127.59	127.59	
5	372066	.013	.014	137.08	137.08	
6	612533	.007	.010	132.33	132.33	
	MODIFIED DAMAGES			696.82	696.82	
	DAMAGE REDUCTION			1024.47	1024.47	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	27735	.621	.623	14.43	14.43	
2	92449	.134	.279	166.49	166.49	
3	138674	.062	.050	74.32	74.32	
4	184898	.034	.025	72.39	72.39	
5	277348	.013	.014	87.88	87.88	
6	369797	.007	.010	108.25	108.25	
	DAMAGES W/ TOTAL					

CONTROL AT PROJECTS	525.75	525.75
REDUCTION POSSIBLE W/ TOTAL CONTROL	1195.54	1195.54
RESIDUAL DAMAGES	171.07	171.07

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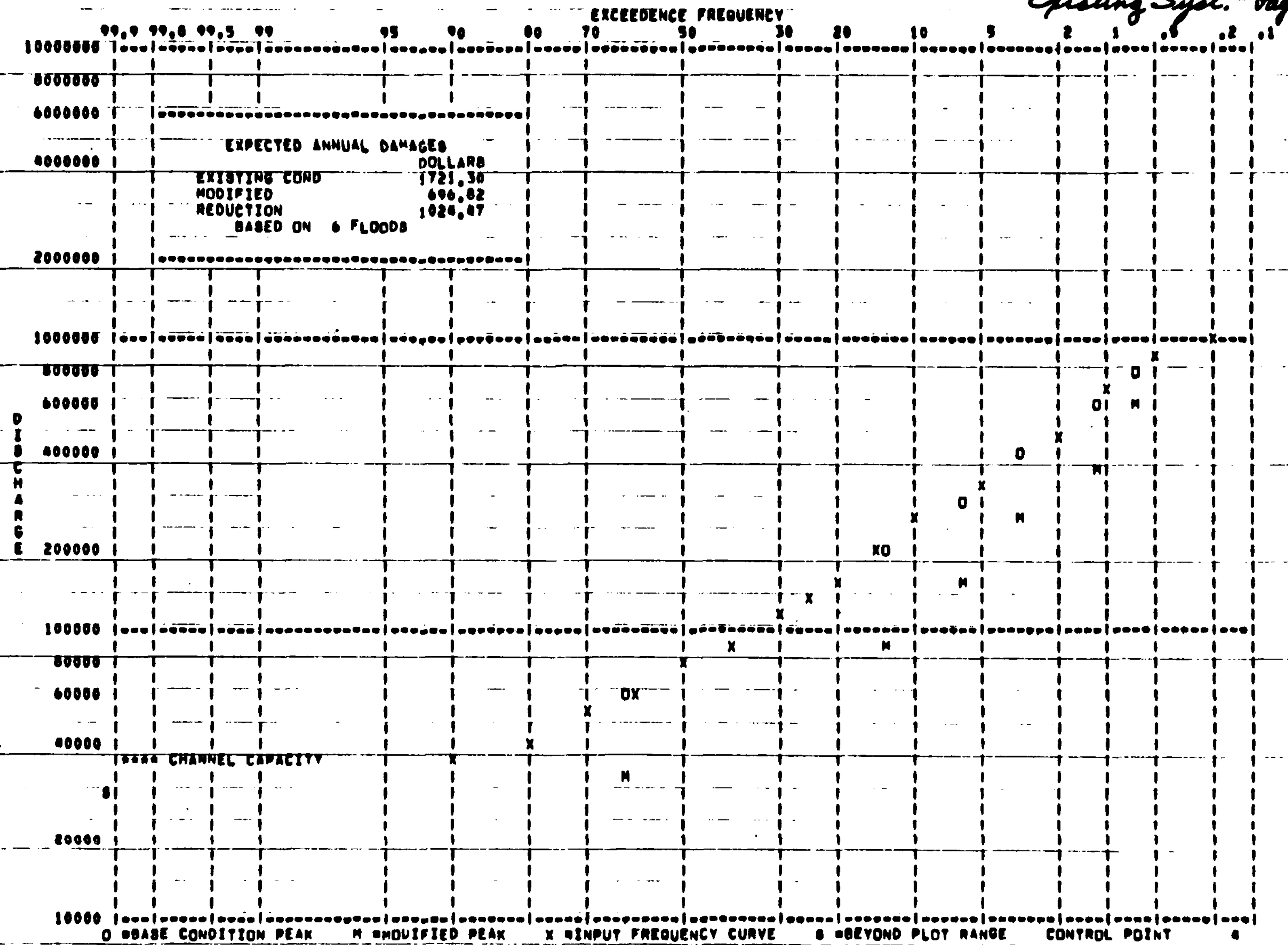
Existing System

Existing Syst. - Rep 77

CONTROL POINT 4



SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES: BASE (EXIST) CONDITION	DAMAGES: MODIFIED CONDITIONS	DAMAGES: UNCONTROL LOCAL COND	DAMAGE REDUCTION: MODIFIED CONDITIONS	DAMAGE REDUCTION: TOTAL CONTROL AT PROJECTS	DAMAGE REDUCTION: RESIDUAL
4	1721.30	696.82	525.75	1024.47	1195.54	171.07
TOTAL	1721.30	696.82	525.75	1024.47	1195.54	171.07

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Existing Syst.

AD-A106 700 HYDROLOGIC ENGINEERING CENTER DAVIS CA F/G 13/2
ANALYSIS OF STRUCTURAL AND NONSTRUCTURAL FLOOD CONTROL MEASURES--ETC(U)
NOV 75 W K JOHNSON, D W DAVIS
UNCLASSIFIED HEC-TD-7 NL

2 of 3
AD A106700

Page 29
Reservoir B

HEC-5C-VARIABLE OUTPUT MAR.1975
RES.= 35 CPTS.= 75 PERS.=100

T1 FALL RIVER BASIN *** RESERVOIR B AT CP 2 ***
T2 TRAINING DOCUMENT NO. 7
T3 FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES

J1	18.00	6.00	4.00	2.00	3.00	-0.00	-0.00	1.00	-0.00	1.00
J2	-0.00	1.10	2.00	1.00	-0.00	0.00	-1.00	-0.00	-0.00	-1.00
J4	6.00	.30	1.00	1.50	2.00	3.00	4.00	-0.00	-0.00	-0.00
RL	1.00	50000.00	-0.00	0.00	50000.00	150832.00	200000.00	-0.00	-0.00	-0.00
RO	1.00	2.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RS	6.00	0.00	50000.00	70000.00	100000.00	150832.00	200000.00	-0.00	-0.00	-0.00
RQ	6.00	5000.00	6000.00	7000.00	8000.00	100000.00	200000.00	-0.00	-0.00	-0.00
CP	1.00	6000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ID RESERVOIR A (CP 1)					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	1.00	2.00	.20	.30	6.00	-0.00	-0.00	-0.00	-0.00	-0.00
Reservoir B Data RL	2.00	100000.00	-0.00	0.00	100000.00	654576.00	1000000.00	-0.00	-0.00	-0.00
RO	1.00	4.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RS	7.00	0.00	100000.00	200000.00	400000.00	600000.00	800000.00	1000000.00	-0.00	-0.00
Reservoir Cost RQ	7.00	18000.00	21000.00	30000.00	40000.00	100000.00	300000.00	500000.00	-0.00	-0.00
RS	7.00	0.00	0.00	0.00	0.00	59150.00	59150.00	0.00	-0.00	-0.00
CP	2.00	21000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	.06	1.20
ID RESERVOIR B (CP 2)					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	2.00	4.00	.20	.30	6.00	-0.00	-0.00	-0.00	-0.00	-0.00
RL	3.00	100000.00	-0.00	0.00	100000.00	755408.00	1000000.00	-0.00	-0.00	-0.00
RO	1.00	4.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RS	7.00	0.00	100000.00	200000.00	400000.00	700000.00	800000.00	1000000.00	-0.00	-0.00,
RQ	7.00	10000.00	12000.00	18000.00	30000.00	80000.00	150000.00	500000.00	-0.00	-0.00
CP	3.00	12000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ID RESERVOIR C (CP 3)					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	3.00	4.00	.20	.30	6.00	-0.00	-0.00	-0.00	-0.00	-0.00
CP	4.00	35000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ID CP 4					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	4.00	5.00	.20	.30	6.00	-0.00	-0.00	-0.00	-0.00	-0.00
DA	1.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
DB	1.00	696.82	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
DF	17.00	1.00	.90	.80	.70	.60	.50	.40	.30	.25
DF	.20	.15	.10	.05	.02	.01	.01	.00	-0.00	-0.00
DQ	17.00	28800.00	35000.00	42000.00	50500.00	60500.00	73000.00	90000.00	114000.00	130000.00
DQ	150000.00	180000.00	230000.00	323000.00	490000.00	640000.00	840000.00	1000000.00	-0.00	-0.00
DC	1.00	0.00	0.00	180.00	380.00	500.00	630.00	900.00	1250.00	1500.00
DC	1930.00	2660.00	5000.00	9900.00	12280.00	13350.00	14150.00	14600.00	-0.00	-0.00
CP	5.00	37000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ID CP 5					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	5.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ED	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

```
     NRES=     3  NCPT=     5  NCPTR=     =0

IN    1  6 JUNE    1000.0    2000.0    3000.0   18000.0   37000.0   82000.0   50000.0   27000.0   20000.0   13000.0
                   5000.0    4000.0    3000.0    2000.0    1000.0    1000.0    1000.0    1000.0
IN    2  6 JUNE    2000.0    3000.0    4000.0    6000.0   20000.0   57000.0  100000.0   90000.0   70000.0   50000.0   SUM=    231000
                  37000.0   24000.0   24000.0   15000.0    9000.0    3000.0    2000.0    1500.0
IN    3  6 JUNE    3000.0    6000.0   27000.0   60000.0  105000.0   78000.0   60000.0   45000.0   33000.0   24000.0   SUM=    517500
                  18000.0   12000.0   12000.0    9000.0    6000.0    3000.0    2000.0    1000.0
IN    4  6 JUNE    2000.0    4000.0   19000.0   13000.0   10000.0    7000.0    4000.0    1000.0    1000.0    8000.0   SUM=    504000
                  10000.0   25000.0   13000.0    7000.0    4000.0    2000.0    1000.0     500.0
IN    5  6 JUNE    1000.0    2000.0    9000.0    6000.0    5000.0    3000.0    2000.0     500.0     500.0    2000.0   SUM=    127500
                   5000.0   12000.0    6000.0    4000.0    2000.0    1000.0     500.0     200.0
EJ   =0              -0.0      -0.0      -0.0      -0.0      -0.0      -0.0      -0.0      -0.0                       SUM=     61700
```

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Reservoir B

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Reservoir B

SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850,00	3850,00	3850,00	3849,62	,03	2,04	53909,35
2	8625,00	12474,98	12470,37	12470,37	,02	2,01	105285,13
3	8400,00	8400,00	8400,00	8400,00	,46	2,02	109958,31

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	Q SPACE	Q BY US	FLOOD BY
4	2125,00	23035,43	22992,39	12007,61	20867,39	0,00
5	3176,27	24083,97	23833,07	13166,93	20656,80	62,02

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRD= 1 NFLCUN= 6
IFLRD = 1 IFLCUN= 2
FLOWS MULTIPLIED BY 1,00

****

**** LOC 1 RESERVOIR A (CP 1) SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 0,YEAR=19 0,

SERVING 1 2

PER CUM LOCAL Q

PER										
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833,333 MAX= 50000,000
MIN= 1000,000

PER NATURAL FLOW

PER										
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833,333 MAX= 50000,000
MIN= 1000,000

PER INFLOW

PER										
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833,333 MAX= 50000,000
MIN= 1000,000

PER OUTFLOW

PER										
1	1000	2000	3000	6147	6000	6000	6000	6000	6000	6000
11	6000	6000	6000	6000	6000	6000	6000	6000		

AVG= 5381,497 MAX= 6146,981
MIN= 1000,000

```
PER        CASE=LOC.TYP

    1     .03     .03     .03     .00     .01     .01     .01     .01     .01     .01
   11     .01     .01     .01     .01     .01     .01     .01     .01
                                                                                        AVG=      .016  MAX=       .000
                                                                                                        MIN=       .010
PER        LEVEL

    1   2.000   2.000   2.000   2.058   2.211   2.380   2.604   2.707   2.776   2.811
   11   2.806   2.796   2.781   2.762   2.737   2.712   2.688   2.663
                                                                                        AVG=     2.528  MAX=      2.811
                                                                                                        MIN=      2.000
PER        EOP STORAGE

    1   50000   50000   50000   55878   71250   89101  110920  121333  128275  131747
   11  131251  130259  128771  126788  124308  121829  119350  116870
                                                                                        AVG= 103218.294  MAX= 131746.511
                                                                                                         MIN=  50000.000
*****************************************************************************************************************************
**** LOC     2  RESERVOIR B (CP 2)                   SERVED BY     1     2

                                                                                        STARTING TIME=      1
                                                                                        HOUR=12,DAY= 4,MON= 0,YEAR=19 0,
                                        SERVING       2     4
PER        CUM LOCAL Q

    1    2000    3000    4000    6000   20000   57000  100000   90000   70000   50000
   11   37000   24000   28000   15000    9000    3000    2000    1500
                                                                                        AVG=  28750.000  MAX= 100000.000
                                                                                                         MIN=   1500.000
PER        NATURAL FLOW

    1    3000    4167    6028   11338   39056   91843  142140  134857   98809   70302
   11   49884   30147   20191   18032   11065    4168    3028    2505
                                                                                        AVG=  41583.282  MAX= 142140.454
                                                                                                         MIN=   2504.658
PER        INFLOW

    1    3000    4167    6028    9362   25658   62943  105991   95998   76000   56000
   11   43000   30000   30000   21000   15000    9000    8000    7500
                                                                                        AVG=  33813.719  MAX= 105990.510
                                                                                                         MIN=   3000.000
PER        OUTFLOW

    1    3000    4167    6028    9362   21000       0   21000   21000   21000   19068
   11    6525       0   21000   21000   21000   21000   21000   21000
                                                                                        AVG=  14341.632  MAX=  21000.000
                                                                                                         MIN=       .000
PER        CASE=LOC.TYP

    1     .03     .03     .03     .03     .01    4.00     .01     .01     .01    4.00
   11    4.01    4.00     .01     .01     .01     .01     .01     .01
                                                                                        AVG=      .902  MAX=      4.010
                                                                                                        MIN=       .010
PER        LEVEL

    1   2.000   2.000   2.000   2.000   2.004   2.060   2.136   2.204   2.253   2.286
```

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Reservoir B

```
  11   2.318   2.345   2.353   2.353   2.348   2.337   2.325   2.313
                                                                                 AVG=     2.202  MAX=     2.353
                                                                                                 MIN=     2.000
 PER        EQUIVALENT LEVEL

   1   2.000   2.000   2.000   2.009   2.036   2.111   2.208   2.281   2.333   2.366
  11   2.393   2.415   2.419   2.416   2.408   2.395   2.381   2.367
                                                                                 AVG=     2.252  MAX=     2.419
                                                                                                 MIN=     2.000
 PER        EOP STORAGE

   1  100000  100000  100000  100000  102310  133522  175667  212856  240129  258443
  11  276530  291407  295869  295869  292894  286944  280497  273803
                                                                                 AVG= 212041.170  MAX= 295869.421
                                                                                                  MIN= 100000.000
************************************************************************************************************
**** LOC     3  RESERVOIR C (CP 3)              SERVED BY     3

                                                                                 STARTING TIME=       1
                                                                                 HOUR=12,DAY= 4,MON= 0,YEAR=19 0,
                                        SERVING        3     4
 PER        CUM LOCAL Q

   1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
  11   18000   12000   12000    9000    6000    3000    2000    1000
                                                                                 AVG=  28000.000  MAX= 105000.000
                                                                                                  MIN=   1000.000
 PER        NATURAL FLOW

   1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
  11   18000   12000   12000    9000    6000    3000    2000    1000
                                                                                 AVG=  28000.000  MAX= 105000.000
                                                                                                  MIN=   1000.000
 PER        INFLOW

   1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
  11   18000   12000   12000    9000    6000    3000    2000    1000
                                                                                 AVG=  28000.000  MAX= 105000.000
                                                                                                  MIN=   1000.000
 PER        OUTFLOW

   1    3000    6000   12000   12000   12000    9159   12000   12000   12000       0
  11       0       0   12000    4050   12000   12000   12000   12000
                                                                                 AVG=   8567.131  MAX=  12000.000
                                                                                                  MIN=       .000
 PER        CASE=LOC,TYP

   1     .03     .03     .01     .01     .01    4.00     .01     .01     .01    4.00
  11    4.01    4.00     .01    4.00     .01     .01     .01     .01
                                                                                 AVG=     1.121  MAX=      4.010
                                                                                                 MIN=       .010
 PER        LEVEL

   1   2.000   2.000   2.011   2.048   2.118   2.170   2.206   2.231   2.247   2.265
  11   2.279   2.288   2.288   2.292   2.287   2.281   2.273   2.265

                                                                                 AVG=     2.197  MAX=     2.292
```

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Reservoir B

```
                                                                                            MIN=      0,000
PER        EOP STORAGE

  1  100000  100000  107438  131240  177356  211493  235295  251659  262072  273973
 11  282899  288850  288850  291304  286329  283866  278908  273453

                                                                          AVG= 229277,000  MAX= 291304,435
                                                                                           MIN= 100000,000
**********************************************************************************************************
**** LOC.    4  CP 4                        SERVED BY   -1    2    3

PER        CUM LOCAL Q

  1    2000    4000   19000   13000   10000    7000    4000    1000    1000    4000
 11   10000   25000   13000    7000    4000    2000    1000     500

                                                                          AVG=   7083,333  MAX=  25000,000
                                                                                           MIN=    500,000
PER        NATURAL FLOW

  1    8000   10694   32398   49141   87592  144277  173798  194036  175045  136597
 11  106281   93327   59185   45997   31355   19091    9465    5847

                                                                          AVG=  76784,776  MAX= 194036,091
                                                                                           MIN=   5846,858
PER        REGULATED FLOW

  1    8000   10694   29898   30395   32641   34300   20156   31193   33532   34600
 11   28899   32500   19750   34300   30750   33958   33826   33471

                                                                          AVG=  28492,417  MAX=  34599,960
                                                                                           MIN=   6000,000
PER        Q SPACE AVAIL.

  1   27000   24306    5102    4605    2359     700   14844    3807    1468     400
 11    6101    2500   15250     700    4250    1042    1174    1529

                                                                          AVG=   6507,583  MAX=  27000,000
                                                                                           MIN=    400,000
PER        Q BY US RES,DIVS

  1    6000    6094   10898   17395   22641   27300   16156   30193   32532   30600
 11   18899    7500    6750   27300   26750   31958   32826   32971

                                                                          AVG=  21409,084  MAX=  32971,000
                                                                                           MIN=   6000,000
PER        FLOOD BY RES

  1       0       0       0       0       0       0       0       0       0       0
 11       0       0       0       0       0       0       0       0

                                                                          AVG=      0,000  MAX=      0,000
                                                                                           MIN=      0,000
**********************************************************************************************************
**** LOC     5  CP 5                        SERVED BY   -1   -2   -3

PER        CUM LOCAL Q

  1    3000    4333   15222   21870   17978   12996    8999    4500    2000    3583
 11    9597   23000   26767   17294    9549    5258    2710    1318

                                                                          AVG=  10587,575  MAX=  26766,509
                                                                                           MIN=   1318,203
PER        NATURAL FLOW
```

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Reservoir B

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Reservoir B

```
   1    9000   10449   22937   38112   57711   94226  142355  172097  187631  172652
  11  142220  121279   96295   66172   48252   32794   20104   10752
                                                                                          AVG=  80279,898  MAX= 187631,160
                                                                                                           MIN=   9000,000
PER        REGULATED FLOW

   1    9000   10449   22521   33251   35246   35518   33646   24410   30869   35183
  11   38414   42252   36000   27883   33972   32488   34025   33917
                                                                                          AVG=  30502,405  MAX=  42251,723
                                                                                                           MIN=   9000,000
PER        Q SPACE AVAIL,

   1   28000   26551   14479    3749    1754    1482    3354   12590    6131    1817
  11   -1414   -5252    1000    9117    3028    4512    2975    3083
                                                                                          AVG=   6497,595  MAX=  28000,000
                                                                                                           MIN=  -5251,723
PER        Q BY US RES,DIVS

   1    6000    6116    7299   11381   17267   22522   24646   19910   28869   31600
  11   28816   18652    9238   10589   24823   27230   31315   32599
                                                                                          AVG=  19910,830  MAX=  32599,587
                                                                                                           MIN=   6000,000
PER        FLOOD BY RES

   1       0       0       0       0       0       0       0       0       0       0
  11    1414    5252       0       0       0       0       0       0
                                                                                          AVG=    370,299  MAX=   5251,723
                                                                                                           MIN=      0,000
**************************************************************************************************************************

                   CUM TIME=      1

RES NO=            1       2       3
INFLOW          1000    3000    3000
OUTFLOW         1000    3000    3000
EOP STOR       50000  100000  100000
CASE=            ,03     ,03     ,03
LEVEL          2,000   2,000   2,000
EQ LEVEL       2,000   2,000   2,000

                   CUM TIME=      2

RES NO=            1       2       3
INFLOW          2000    4167    6000
OUTFLOW         2000    4167    6000
EOP STOR       50000  100000  100000
CASE=            ,03     ,03     ,03
LEVEL          2,000   2,000   2,000
EQ LEVEL       2,000   2,000   2,000

                   CUM TIME=      3

RES NO=            1       2       3
INFLOW          3000    6028   27000
```

```
FALL RIVER BASIN   ***   RESERVOIR B AT CP 2   ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .3  1.0  1.5  2.0  3.0  4.0  USED TO COMPUTE ANNUAL DAMAGES
                                                    FLOOD SUMMARY-EACH FLOOD COPY=     1

                         ***** FLOOD NUMBER  1 *****

                                                                        STARTING TIME      1
                                                                                  SHORTAGE INDEX
                          FLD.PER  MAX REG Q *  FLD.PER  MAX NAT Q *  FLD.PER  MAX LOC Q * Q BY RES *  DES    REQ
LOC   4  CP 4               1.011    34700 *      1.008    58211 *      1.012     7500 *    27200 *   0.00   0.00
LOC   5  CP 5               1.012    38131 *      1.009    56289 *      1.013     8030 *    30101 *   0.00   0.00

        RESERVOIRS        FLD.PER  MIN STG MIN LEVEL * FLD.PER  MAX STG MAX LEVEL * FLD.PER  MAX REL  CHAN CAP   STOR1

LOC   1  RESERVOIR A (CP 1)   1.004   50000    2.000 *   1.008    61274    2.112 *   1.005    6062     6000    50000
LOC   2  RESERVOIR B (CP 2)   1.018  100000    2.000 *   1.009   117318    2.031 *   1.006   21000    21000   100000
LOC   3  RESERVOIR C (CP 3)   1.018  100000    2.000 *   1.008   122016    2.034 *   1.004   12000    12000   100000
                 MIN SYSTEM STG=   250000    MAX SYSTEM STG=    300608

                         ***** FLOOD NUMBER  2 *****

                                                                        STARTING TIME      1
                                                                                  SHORTAGE INDEX
                          FLD.PER  MAX REG Q *  FLD.PER  MAX NAT Q *  FLD.PER  MAX LOC Q * Q BY RES *  DES    REQ
LOC   4  CP 4               2.010    34600 *      2.008   194036 *      2.012    25000 *     9600 *   0.00   0.00
LOC   5  CP 5               2.012    42252 *      2.009   187631 *      2.013    26767 *    15485 *   0.00   0.00

        RESERVOIRS        FLD.PER  MIN STG MIN LEVEL * FLD.PER  MAX STG MAX LEVEL * FLD.PER  MAX REL  CHAN CAP   STOR1

LOC   1  RESERVOIR A (CP 1)   2.003   50000    2.000 *   2.010   131746    2.811 *   2.004    6146     6000    50000
LOC   2  RESERVOIR B (CP 2)   2.004  100000    2.000 *   2.013   295869    2.353 *   2.005   21000    21000   100000
LOC   3  RESERVOIR C (CP 3)   2.002  100000    2.000 *   2.014   291304    2.292 *   2.003   12000    12000   100000
                 MIN SYSTEM STG=   250000    MAX SYSTEM STG=    718919

                         ***** FLOOD NUMBER  3 *****

                                                                        STARTING TIME      1
                                                                                  SHORTAGE INDEX
                          FLD.PER  MAX REG Q *  FLD.PER  MAX NAT Q *  FLD.PER  MAX LOC Q * Q BY RES *  DES    REQ
LOC   4  CP 4               3.012    38262 *      3.008   291054 *      3.012    37500 *      762 *   0.00   0.00
LOC   5  CP 5               3.013    42798 *      3.009   281447 *      3.013    40150 *     2648 *   0.00   0.00

        RESERVOIRS        FLD.PER  MIN STG MIN LEVEL * FLD.PER  MAX STG MAX LEVEL * FLD.PER  MAX REL  CHAN CAP   STOR1
```

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Reservoir B

LOC	1	RESERVOIR A (CP 1)	3,002	50000	2,000 *	3,008	150832	3,000 *	3,008	38158	6000	50000
LOC	2	RESERVOIR B (CP 2)	3,001	100000	2,000 *	3,014	483597	2,692 *	3,006	21000	21000	100000
LOC	3	RESERVOIR C (CP 3)	3,001	100000	2,000 *	3,014	426307	2,898 *	3,008	12000	12000	100000

MIN SYSTEM STG= 250000 MAX SYSTEM STG= 1060736

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Reservoir B

***** FLOOD NUMBER 4 *****

STARTING TIME 1

			FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC	4	CP 4	4,012	54228 *	4,008	388072 *	4,012	50000 *	4228 *	0,00	0,00
LOC	5	CP 5	4,013	60627 *	4,009	375262 *	4,013	53533 *	7094 *	0,00	0,00

		RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	4,001	50000	2,000 *	4,007	150832	3,000 *	4,007	82658	6000	50000
LOC	2	RESERVOIR B (CP 2)	4,001	102975	2,005 *	4,014	654576	3,000 *	4,014	23051	21000	100000
LOC	3	RESERVOIR C (CP 3)	4,001	102975	2,005 *	4,015	564840	2,709 *	4,004	12000	12000	100000

MIN SYSTEM STG= 255950 MAX SYSTEM STG= 1370248

***** FLOOD NUMBER 5 *****

STARTING TIME 1

			FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC	4	CP 4	5,012	270763 *	5,008	582108 *	5,012	75000 *	195763 *	0,00	0,00
LOC	5	CP 5	5,013	269295 *	5,009	562893 *	5,013	80300 *	186995 *	0,00	0,00

		RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	5,001	50000	2,000 *	5,007	167676	3,343 *	5,007	118246	6000	50000
LOC	2	RESERVOIR B (CP 2)	5,001	104463	2,008 *	5,010	702719	3,139 *	5,010	196361	21000	100000
LOC	3	RESERVOIR C (CP 3)	5,001	104463	2,007 *	5,012	755408	3,000 *	5,013	35999	12000	100000

MIN SYSTEM STG= 258924 MAX SYSTEM STG= 1625803

***** FLOOD NUMBER 6 *****

STARTING TIME 1

			FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC	4	CP 4	6,012	497775 *	6,008	776144 *	6,012	100000 *	397775 *	0,00	0,00
LOC	5	CP 5	6,012	506408 *	6,009	750525 *	6,013	107066 *	399341 *	0,00	0,00

		RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	6,001	50000	2,000 *	6,007	191183	3,821 *	6,007	163829	6000	50000
LOC	2	RESERVOIR B (CP 2)	6,001	105950	2,011 *	6,009	811202	3,453 *	6,010	310627	21000	100000

LOC 3 RESERVOIR C (CP 3) 6,001 105950 2,009 * 6,008 781273 3,106 * 6,009 136168 12000 100000

MIN SYSTEM STG= 261900 MAX SYSTEM STG= 1783658

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	680000	13350.00	13350.00	
.0050	880000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES

	SUM	TYPE 1
BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00
EXIST SYSTEM-INPUT	696.82	696.82

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.034	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776144	.007	.010	138.03	138.03	

	SUM	TYPE 1
BASE COND DAMAGES	1721.30	1721.30
EXST SYST DAMAGES	696.82	696.82

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	34700	.621	.623	0.00	0.00	
2	34600	.134	.279	.30	.30	
3	38262	.062	.050	4.06	4.06	
4	54228	.034	.025	15.13	15.13	
5	270763	.013	.014	68.96	68.96	
6	497775	.007	.010	126.11	126.11	

	SUM	TYPE 1
MODIFIED DAMAGES	214.55	214.55
DAMAGE REDUCTION	482.27	482.27

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	7500	.621	.623	0.00	0.00	
2	25000	.134	.279	0.00	0.00	

3	37500	.002	.050	2.06	2.06
4	50000	.034	.025	8.31	8.31
5	75000	.013	.014	8.27	8.27
6	100000	.007	.010	12.09	12.09
DAMAGES W/ TOTAL CONTROL AT PROJECTS				30.74	30.74
REDUCTION POSSIBLE W/ TOTAL CONTROL				666.08	666.08
RESIDUAL DAMAGES				183.81	183.81

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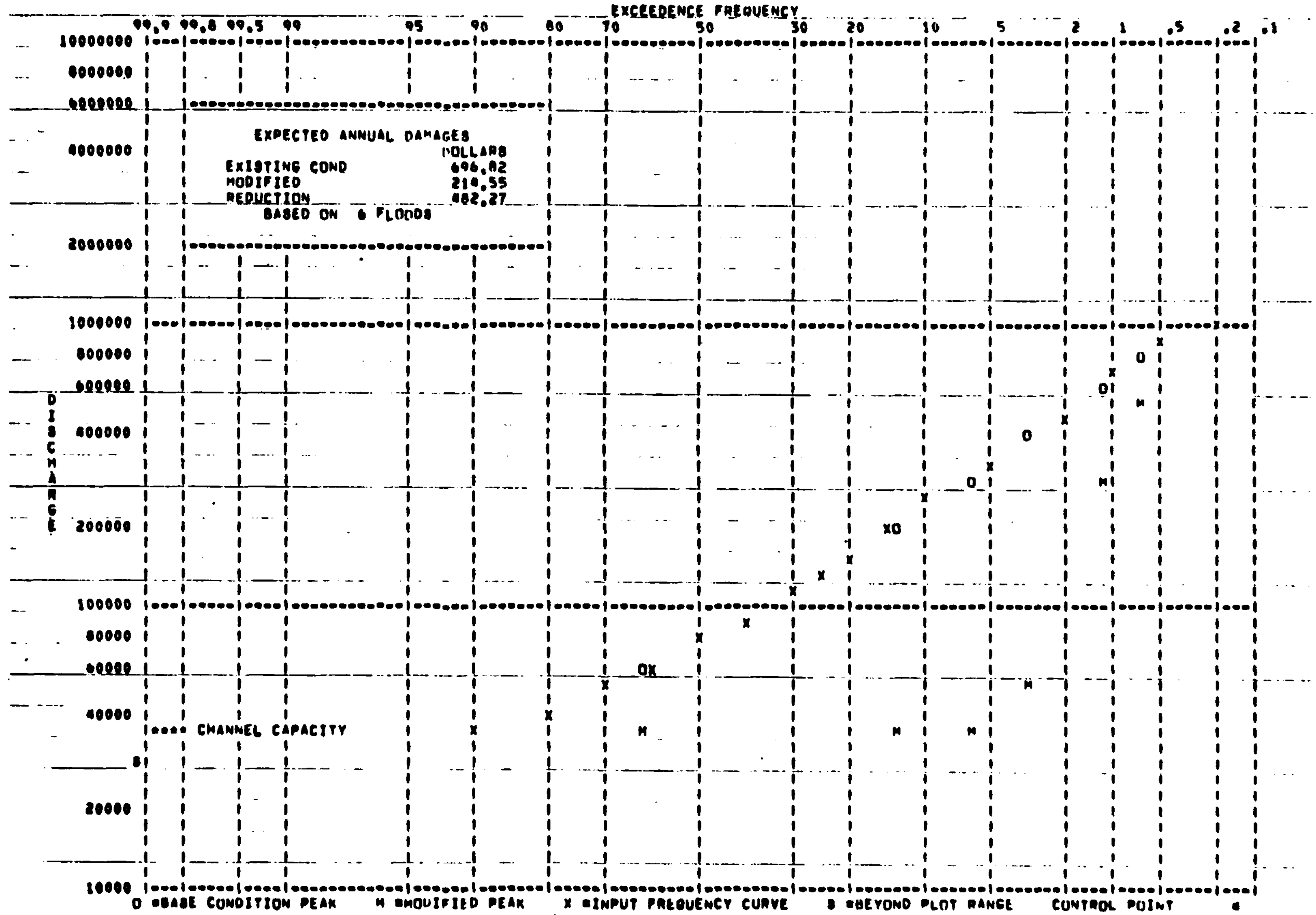
CONTROL POINT 4



SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES: BASE (EXIST) CONDITION	DAMAGES: MODIFIED CONDITIONS	DAMAGES: UNCONTROL LOCAL COND	DAMAGE REDUCTION: MODIFIED CONDITIONS	DAMAGE REDUCTION: TOTAL CONTROL AT PROJECTS	DAMAGE REDUCTION: RESIDUAL
4	696.82	214.55	30.74	482.27	666.08	183.81
TOTAL	696.82	214.55	30.74	482.27	66[illegible].08	183.81

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SYSTEM ECONOMIC COST AND PERFORMANCE SUMMARY
(EXCLUSIVE OF EXISTING SYSTEM COSTS)

TOTAL SYSTEM CAPITAL COST * * * * * * *	59150.00	
TOTAL SYSTEM ANNUAL OPERATING MAINTENANCE, AND REPAIR COST * * * *	709.60	
TOTAL SYSTEM ANNUAL COST * * * * * * *		4199.65
AVERAGE ANNUAL DAMAGES - EXISTING SYSTEM	696.82	
AVERAGE ANNUAL DAMAGES - PROPOSED SYSTEM	214.55	
AVERAGE ANNUAL DAMAGE REDUCTION		482.27
AVERAGE ANNUAL SYSTEM NET DAMAGE REDUCTION BENEFITS		-3717.38

```
        HEC-5C-VARIABLE OUTPUT MAR,1975
        RES,= 35 CPTS,= 75 PERS,=100

T1 FALL RIVER BASIN   ***   LEVEE OR FLOODWALL   ***
T2 TRAINING DOCUMENT NO. 7
T3 FLOOD RATIOS .3  1.0  1.5  2.0  3.0  4.0  USED TO COMPUTE ANNUAL DAMAGES
J1       10.00       6.00       4.00       2.00       3.00      -0.00      -0.00       1.00      -0.00       1.00
J2       -0.00       1.10       2.00       1.00      -0.00       0.00      -1.00      -0.00      -0.00      -1.00
J4        6.00        .30       1.00       1.50       2.00       3.00       4.00      -0.00      -0.00      -0.00

RL        1.00   50000.00      -0.00       0.00   50000.00  150832.00  200000.00      -0.00      -0.00      -0.00
RO        1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RS        6.00       0.00   50000.00   70000.00  100000.00  150832.00  200000.00      -0.00      -0.00      -0.00
RQ        6.00    5000.00    6000.00    7000.00    8000.00  100000.00  200000.00      -0.00      -0.00      -0.00

CP        1.00    6000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID RESERVOIR A (CP 1)                                -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT        1.00       2.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

CP        2.00   21000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 2                                              -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT        2.00       4.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

RL        3.00  100000.00      -0.00       0.00  100000.00  755408.00 1000000.00      -0.00      -0.00      -0.00
RO        1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RS        7.00       0.00  100000.00  200000.00  400000.00  700000.00  800000.00 1000000.00      -0.00      -0.00
RQ        7.00   10000.00   12000.00   18000.00   30000.00   80000.00  150000.00  500000.00      -0.00      -0.00

CP        3.00   12000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID RESERVOIR C (CP 3)                                -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT        3.00       4.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

CP        4.00  287000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00        .06       1.00
ID CP 4                                              -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT        4.00       5.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00
DB        1.00  287000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
CB   287000.00    5510.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DA        1.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DB        1.00     696.82      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DF       17.00       1.00        .90        .80        .70        .60        .50        .40        .30        .25
DF         .20        .15        .10        .05        .02        .01        .01        .00      -0.00      -0.00
DQ       17.00   28800.00   35000.00   42000.00   50500.00   60500.00   73000.00   90000.00  114000.00  130000.00
DQ   150000.00  180000.00  230000.00  323000.00  490000.00  646000.00  880000.00 1000000.00      -0.00      -0.00
DC        1.00       0.00       0.00     180.00     300.00     500.00     630.00     900.00    1250.00    1500.00
DC     1930.00    2660.00    5000.00    9900.00   12280.00   13350.00   14150.00   14600.00      -0.00      -0.00
DC        1.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00
DC        0.00       0.00       0.00    9900.00   12280.00   13350.00   14150.00   14600.00      -0.00      -0.00

CP        5.00   37000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 5                                              -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT        5.00       0.00       0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ED       -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00

      NRES=    2  NCPT=    5  NCPTA=    =0

IN     1  6 JUNE    1000.0     2000.0     3000.0    18000.0    37000.0    42000.0    50000.0    27000.0    20000.0    13000.0
```

Levee or Floodwall
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			5000.0	4000.0	3000.0	2000.0	1000.0	1000.0	1000.0	1000.0				
													SUM=	231000
IN	2	6 JUNE	2000.0	3000.0	4000.0	6000.0	20000.0	57000.0	100000.0	90000.0	70000.0	50000.0		
			37000.0	24000.0	24000.0	15000.0	9000.0	3000.0	2000.0	1500.0				
													SUM=	517500
IN	3	6 JUNE	3000.0	6000.0	27000.0	60000.0	105000.0	78000.0	60000.0	45000.0	53000.0	24000.0		
			18000.0	12000.0	12000.0	9000.0	6000.0	3000.0	2000.0	1000.0				
													SUM=	504000
IN	4	6 JUNE	2000.0	4000.0	19000.0	13000.0	10000.0	7000.0	4000.0	1000.0	1000.0	4000.0		
			10000.0	25000.0	13000.0	7000.0	4000.0	2000.0	1000.0	500.0				
													SUM=	127500
IN	5	6 JUNE	1000.0	2000.0	9000.0	6000.0	5000.0	3000.0	2000.0	500.0	500.0	2000.0		
			5000.0	12000.0	6000.0	4000.0	2000.0	1000.0	500.0	200.0				
													SUM=	61700
EJ	-0		-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0				

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Levee or Fldw.

SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850.00	3850.00	3850.00	3850.00	.02	2.04	53818.24
3	8400.00	8400.00	8400.00	8400.00	.02	2.01	108479.46

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	Q SPACE	Q BY US	FLOOD BY
2	8625.00	12474.98	12474.56	8525.44	3849.56	1104.09
4	10755.92	23035.03	23027.12	263972.08	12271.20	0.00
5	11795.97	24083.97	24016.64	12983.36	12220.67	1237.74

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRD= 1 NFLCUM= 6
IFLRD = 1 IFLCUM= 2
FLOWS MULTIPLIED BY 1.00

****

**** LOC 1 RESERVOIR A (CP 1) SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 6,YEAR=19 0,

SERVING 1 4

PER CUM LOCAL Q

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12033.333 MAX= 50000.000
MIN= 1000.000

PER NATURAL FLOW

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12033.333 MAX= 50000.000
MIN= 1000.000

PER INFLOW

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12033.333 MAX= 50000.000
MIN= 1000.000

PER OUTFLOW

1	1000	2000	3000	6000	6000	6000	6000	6000	6000	6000
11	6000	6000	6000	6000	6000	6000	6000	6000		

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Serve Fr Floodwall

AVG= 5333.333 MAX= 6000.000
MIN= 1000.000

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Levee or Floodwall

```
PER      CASE=LOC.TYP

   1    .03    .03    .03    .01    .01    .01    .01    .01    .01    .01
  11    .01    .01    .01    .01    .01    .01    .01    .01
                                                                          AVG=       .013  MAX=       .030
                                                                                           MIN=       .010
PER      LEVEL

   1  2.000  2.000  2.000  2.059  2.211  2.309  2.405  2.700  2.777  2.811
  11  2.807  2.797  2.782  2.762  2.738  2.713  2.689  2.664
                                                                          AVG=      2.528  MAX=      2.811
                                                                                           MIN=      2.000
PER      EOP STORAGE

   1  50000  50000  50000  55950  71323  89174 110993 121406 128348 131819
  11 131323 130332 128844 126861 124381 121902 119422 116943
                                                                          AVG= 103279.014  MAX= 131819.375
                                                                                           MIN=  50000.000
*****************************************************************************************************
**** LOC     2  CP 2                          SERVED BY    =1

PER      CUM LOCAL Q

   1   2000   3000   4000   6000  20000  57000 100000  90000  70000  50000
  11  37000  24000  24000  15000   9000   3000   2000   1500
                                                                          AVG=  28750.000  MAX= 100000.000
                                                                                           MIN=   1500.000
PER      NATURAL FLOW

   1   3000   4167   6028  11338  39096  91843 142140 134887  98809  70302
  11  49884  30147  28191  18032  11005   4168   3028   2505
                                                                          AVG=  41583.282  MAX= 142140.458
                                                                                           MIN=   2504.654
PER      REGULATED FLOW

   1   3000   4167   6028   9338  25556  62926 105988  95998  76000  56000
  11  43000  30000  30000  21000  15000   9000   8000   7500
                                                                          AVG=  33805.556  MAX= 105987.676
                                                                                           MIN=   3000.000
PER      Q SPACE AVAIL.

   1  18000  16833  14972  11662  -4556 -41926 -84988 -74998 -55000 -35000
  11 -22000  -9000  -9000      0   6000  12000  13000  13500
                                                                          AVG= -12805.556  MAX=  18000.000
                                                                                           MIN= -84987.676
PER      Q BY US RES,DIVS

   1   1000   1167   2028   3338   5556   5926   5988   5998   6000   6000
  11   6000   6000   6000   6000   6000   6000   6000   6000
                                                                          AVG=   5055.556  MAX=   6000.000
                                                                                           MIN=   1000.000
PER      FLOOD BY RES

   1      0      0      0      0   4556   5926   5988   5998   6000   6000
  11   6000   6000   6000      0      0      0      0      0
                                                                          AVG=   2914.866  MAX=   6000.000
```

```
                                                                                              MIN=      0.000
*****************************************************************************************************************

**** LOC    3  RESERVOIR C (CP 3)                SERVED BY    2
                                                                              STARTING TIME=      1
                                                                              HOUR=12,DAY= 8,MON= 6,YEAR=19 6.
                                     SERVING     2    4
PER       CUM LOCAL Q

   1   3000   6000  27000  60000 105000  78000  60000  45000  33000  24000
  11  18000  12000  12000   9000   6000   3000   2000   1000

                                                                              AVG=  28000.000  MAX= 105000.000
                                                                                               MIN=   1000.000
PER       NATURAL FLOW

   1   3000   6000  27000  60000 105000  78000  60000  45000  33000  24000
  11  18000  12000  12000   9000   6000   3000   2000   1000

                                                                              AVG=  28000.000  MAX= 105000.000
                                                                                               MIN=   1000.000
PER       INFLOW

   1   3000   6000  27000  60000 105000  78000  60000  45000  33000  24000
  11  18000  12000  12000   9000   6000   3000   2000   1000

                                                                              AVG=  28000.000  MAX= 105000.000
                                                                                               MIN=   1000.000
PER       OUTFLOW

   1   3000   6000  12000  12000  12000  12000  12000  12000  12000  12000
  11  12000  12000  12000  12000  12000  12000  12000  12000

                                                                              AVG=  11166.667  MAX=  12000.000
                                                                                               MIN=   3000.000
PER       CASE=LOC,TYP

   1    .03    .03    .01    .01    .01    .01    .01    .01    .01    .01
  11    .01    .01    .01    .01    .01    .01    .01    .01

                                                                              AVG=       .012  MAX=       .030
                                                                                               MIN=       .010
PER       LEVEL

   1  2.000  2.000  2.011  2.048  2.118  2.168  2.208  2.229  2.245  2.254
  11  2.259  2.259  2.259  2.256  2.252  2.245  2.238  2.229

                                                                              AVG=      2.182  MAX=      2.259
                                                                                               MIN=      2.000
PER       EOP STORAGE

   1 100000 100000 107438 131240 177356 210084 233886 250250 260663 266614
  11 269589 269589 269589 268102 265126 260663 255705 250250

                                                                              AVG= 219230.389  MAX= 269589.250
                                                                                               MIN= 100000.000
*****************************************************************************************************************

**** LOC    4  CP 4                              SERVED BY    1    2

PER       CUM LOCAL Q

   1   4000   6167  22028  17171  18029  31171  62695  92449  87908  73885
  11  61081  62180  39197  29866  19311  11052   4848   2724
```

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Levee or Floodwall

```
                                                                                    AVG=  35853.070  MAX=  92849.206
                                                                                                     MIN=   2723.602
PER        NATURAL FLOW

   1    8000   10694   32398   40141   87592  144277  173798  194036  175845  136597
  11  106281   93327   59185   45997   31355   19091    9465    5847
```

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Levee or Floodwall

```
                                                                                    AVG=  76784.776  MAX= 194036.091
                                                                                                     MIN=   5846.858
PER        REGULATED FLOW

   1    8000   10694   29898   30391   33383   48422   80519  110411  105900   91883
  11   79080   80180   57197   47860   37311   29052   22842   20728

                                                                                    AVG=  51297.515  MAX= 110411.284
                                                                                                     MIN=   8000.000
PER        Q SPACE AVAIL.

   1  279000  276306  257102  256609  253617  238578  206481  176589  181100  195517
  11  207920  206820  229803  239134  249689  257948  264158  266276

                                                                                    AVG= 235702.485  MAX= 279000.000
                                                                                                     MIN= 176588.716
PER        Q BY US RES,DIVS

   1    4000    4528    7870   13220   15355   17251   17824   17962   17992   17998
  11   18000   18000   18000   18000   18000   18000   18000   18000

                                                                                    AVG=  15444.444  MAX=  18000.000
                                                                                                     MIN=   4000.000
PER        FLOOD BY RES

   1       0       0       0       0       0       0       0       0       0       0
  11       0       0       0       0       0       0       0       0

                                                                                    AVG=      0.000  MAX=      0.000
                                                                                                     MIN=      0.000
**************************************************************************************************************************
**** LOC    5  CP 5                                    SERVED BY    -1    -2
PER        CUM LOCAL Q

   1    5000    6361   17509   24965   22613   23150   36588   63870   87279   87316
  11   78389   75315   64539   44865   31940   20706   11959    5792

                                                                                    AVG=  39319.888  MAX=  87316.106
                                                                                                     MIN=   5000.000
PER        NATURAL FLOW

   1    9000   10449   22937   38112   57711   94226  142355  172097  187631  172652
  11  142220  121279   96295   66172   48292   32794   20104   10752

                                                                                    AVG=  80279.898  MAX= 187631.160
                                                                                                     MIN=   9000.000
PER        REGULATED FLOW

   1    9000   10449   22521   33251   35366   38387   53599   81181  103204  105298
  11   96385   93315   82539   62865   49940   38706   29959   23792

                                                                                    AVG=  53986.554  MAX= 105298.240
                                                                                                     MIN=   9000.000
PER        Q SPACE AVAIL.

   1   28000   26551   14479    3749    1634   -1387  -16599  -44181  -68206  -68298
  11  -59385  -56315  -45539  -25865  -12940   -1706    7041   13208
```

AVG= -16986.550 MAX= 20000.000
MIN= -68290.240

PER Q BY US RES,DIVS

1	4000	4088	5012	8285	12753	15237	17011	17711	17925	17982
11	17996	17999	18000	18000	18000	18000	18000	18000		

AVG= 14666.667 MAX= 18000.000
MIN= 4000.000

PER FLOOD BY RES

1	0	0	0	0	0	1387	16599	17711	17925	17982
11	17996	17999	18000	18000	12940	1706	0	0		

AVG= 8791.467 MAX= 17999.962
MIN= 0.000

****

CUM TIME= 1

RES NO=	1	3
INFLOW	1000	3000
OUTFLOW	1000	3000
EOP STOR	50000	100000
CASE=	.03	.03
LEVEL	2.000	2.000
EQ LEVEL	2.000	2.000

CUM TIME= 2

RES NO=	1	3
INFLOW	2000	6000
OUTFLOW	2000	6000
EOP STOR	50000	100000
CASE=	.03	.03
LEVEL	2.000	2.000
EQ LEVEL	2.000	2.000

CUM TIME= 3

RES NO=	1	3
INFLOW	3000	27000
OUTFLOW	3000	12000
EOP STOR	50000	107438
CASE=	.03	.01
LEVEL	2.000	2.011
EQ LEVEL	2.000	2.011

CUM TIME= 4

RES NO=	1	3
INFLOW	18000	60000
OUTFLOW	6000	12000
EOP STOR	55950	131240
CASE=	.01	.01
LEVEL	2.059	2.048
EQ LEVEL	2.059	2.048

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Levee as floodwall

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Levee or Floodwall

FALL RIVER BASIN *** LEVEE OR FLOODWALL ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES
FLOOD SUMMARY-EACH FLOOD COPY= 1

***** FLOOD NUMBER 1 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REG
LOC 2 CP 2	1.007	35969 *	1.007	42642 *	1.007	30000 *	5969 *	0.00	0.00
LOC 4 CP 4	1.008	45647 *	1.008	58211 *	1.008	27735 *	17913 *	0.00	0.00
LOC 5 CP 5	1.010	44155 *	1.009	56289 *	1.010	26195 *	17960 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	1.018	50000	2.000 *	1.008	61305	2.112 *	1.005	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	1.018	100000	2.000 *	1.008	122016	2.034 *	1.004	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 183321

***** FLOOD NUMBER 2 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REG
LOC 2 CP 2	2.007	105988 *	2.007	182140 *	2.007	100000 *	5988 *	0.00	0.00
LOC 4 CP 4	2.008	110411 *	2.008	194036 *	2.008	92449 *	17962 *	0.00	0.00
LOC 5 CP 5	2.010	105298 *	2.009	187631 *	2.010	87316 *	17982 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	2.003	50000	2.000 *	2.010	131819	2.811 *	2.004	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	2.002	100000	2.000 *	2.011	269589	2.259 *	2.003	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 401408

***** FLOOD NUMBER 3 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REG
LOC 2 CP 2	3.007	155993 *	3.007	213211 *	3.007	150000 *	5993 *	0.00	0.00
LOC 4 CP 4	3.008	157420 *	3.008	291054 *	3.008	138674 *	18746 *	0.00	0.00
LOC 5 CP 5	3.010	157351 *	3.009	281447 *	3.010	130974 *	26377 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	3.003	50000	2.000 *	3.008	150832	3.000 *	3.008	33658	6000	50000

LOC	3	RESERVOIR C (CP 3)	3,002	100000	2,000 *	3,014	387855	2,439 *	3,003	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 538687

***** FLOOD NUMBER 4 *****

STARTING TIME 1

			FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	4,008	240290 *	4,007	284281 *	4,007	200000 *	40290 *	0,00	0,00
LOC	4	CP 4	4,009	240589 *	4,008	388072 *	4,008	184898 *	55690 *	0,00	0,00
LOC	5	CP 5	4,010	234515 *	4,009	375262 *	4,010	174632 *	59883 *	0,00	0,00

		RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	4,003	50000	2,000 *	4,007	150832	3,000 *	4,007	72658	6000	50000
LOC	3	RESERVOIR C (CP 3)	4,002	100000	2,000 *	4,014	507609	2,622 *	4,002	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 658441

***** FLOOD NUMBER 5 *****

STARTING TIME 1

			FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	5,008	379367 *	5,007	426421 *	5,007	300000 *	79367 *	0,00	0,00
LOC	4	CP 4	5,009	366161 *	5,008	582108 *	5,008	277348 *	88814 *	0,00	0,00
LOC	5	CP 5	5,010	358326 *	5,009	562893 *	5,010	261948 *	96378 *	0,00	0,00

		RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	5,002	50000	2,000 *	5,007	167314	3,335 *	5,007	116761	6000	50000
LOC	3	RESERVOIR C (CP 3)	5,001	100000	2,000 *	5,012	755408	3,000 *	5,013	35999	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 922722

***** FLOOD NUMBER 6 *****

STARTING TIME 1

			FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	6,007	514878 *	6,007	568562 *	6,007	400000 *	114878 *	0,00	0,00
LOC	4	CP 4	6,009	601884 *	6,008	776144 *	6,008	369797 *	232087 *	0,00	0,00
LOC	5	CP 5	6,010	584489 *	6,009	750525 *	6,010	349264 *	235224 *	0,00	0,00

		RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	6,001	50000	2,000 *	6,007	191183	3,821 *	6,007	163029	6000	50000
LOC	3	RESERVOIR C (CP 3)	6,001	100000	2,000 *	6,009	769930	3,059 *	6,009	128311	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 961113

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Levee & Floodwall

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES		
BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00
EXIST SYSTEM-INPUT	696.82	696.82

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.038	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776144	.007	.010	138.03	138.03	
	BASE COND DAMAGES			1721.30	1721.30	
	EXST SYST DAMAGES			696.82	696.82	

MODIFIED CONDITIONS FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	0.00	0.00	
.7000	50500	0.00	0.00	
.6000	60500	0.00	0.00	
.5000	73000	0.00	0.00	
.4000	90000	0.00	0.00	
.3000	114000	0.00	0.00	
.2500	130000	0.00	0.00	
.2000	150000	0.00	0.00	
.1500	180000	0.00	0.00	
.0640	287000	6067.76	6067.76	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCO FREQ	PROB INT	SUM	TYPE 1	TYPE
1	45647	.621	.623	0.00	0.00	
2	110411	.134	.279	0.00	0.00	
3	157420	.062	.050	0.00	0.00	
4	240589	.034	.025	0.00	0.00	
5	366161	.013	.014	123.94	123.94	
6	601884	.007	.010	131.87	131.87	
	MODIFIED DAMAGES			255.82	255.82	
	DAMAGE REDUCTION			441.00	441.00	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCO FREQ	PROB INT	SUM	TYPE 1	TYPE
1	27735	.621	.623	0.00	0.00	
2	92849	.134	.279	0.00	0.00	
3	138674	.062	.050	0.00	0.00	
4	184898	.034	.025	0.00	0.00	
5	277348	.013	.014	22.01	22.01	
6	369797	.007	.010	107.87	107.87	
	DAMAGES W/ TOTAL CONTROL AT PROJECTS			129.88	129.88	
	REDUCTION POSSIBLE W/ TOTAL CONTROL			566.94	566.94	
	RESIDUAL DAMAGES			125.93	125.93	

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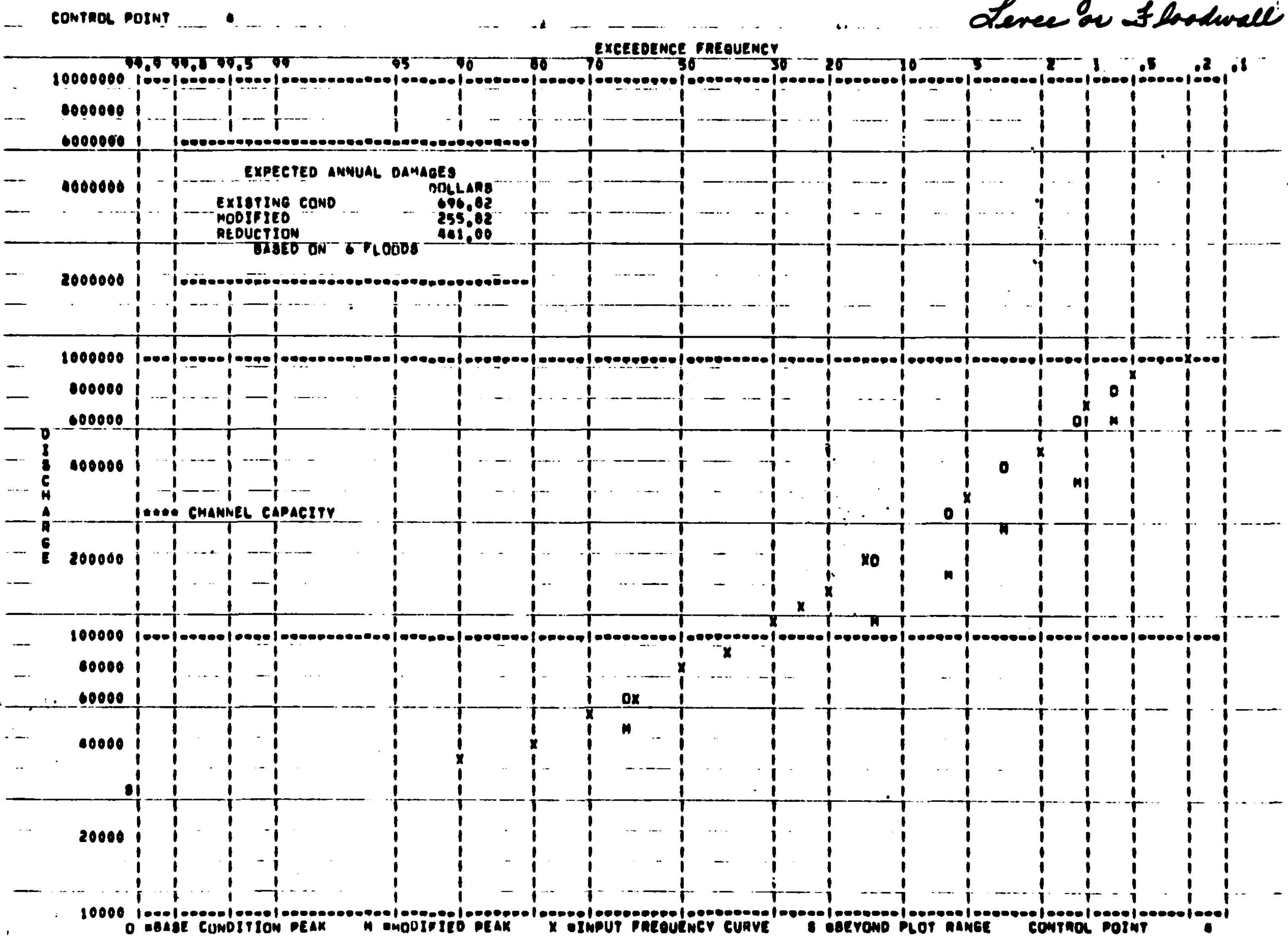

SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES: BASE (EXIST) CONDITION	MODIFIED CONDITIONS	UNCONTROL LOCAL COND	DAMAGE REDUCTION: MODIFIED CONDITIONS	TOTAL CONTROL AT PROJECTS	RESIDUAL
4	696.82	255.82	129.89	441.00	566.93	125.93
TOTAL	696.82	255.82	129.89	441.00	566.93	125.93

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SYSTEM ECONOMIC COST AND PERFORMANCE SUMMARY
(EXCLUSIVE OF EXISTING SYSTEM COSTS)

TOTAL SYSTEM CAPITAL COST * * * * * * * *	5510.00	
TOTAL SYSTEM ANNUAL OPERATING MAINTENANCE, AND REPAIR COST * * * *	55.10	
TOTAL SYSTEM ANNUAL COST * * * * * * * *		380.19
AVERAGE ANNUAL DAMAGES - EXISTING SYSTEM	696.82	
AVERAGE ANNUAL DAMAGES - PROPOSED SYSTEM	255.82	
AVERAGE ANNUAL DAMAGE REDUCTION		441.00
AVERAGE ANNUAL SYSTEM NET DAMAGE REDUCTION BENEFITS		60.81

```
HEC-5C-VARIABLE OUTPUT MAR,1975
RES,= 35 CPTS,= 75 PERS,=100

T1 FALL RIVER BASIN   ***   CHANNEL MODIFICATIONS   ***
T2 TRAINING DOCUMENT NO. 7
T3 FLOOD RATIOS .3  1.0  1.5  2.0  3.0  4.0  USED TO COMPUTE ANNUAL DAMAGES
J1      18.00       6.00       4.00       2.00       3.00      -0.00      -0.00       1.00      -0.00       1.00
J2      -0.00       1.10       2.00       1.00      -0.00       0.00      -1.00      -0.00      -0.00      -1.00
J4       6.00        .30       1.00       1.50       2.00       3.00       4.00      -0.00      -0.00      -0.00

RL       1.00   50000.00      -0.00       0.00   50000.00  150832.00  200000.00      -0.00      -0.00      -0.00
RO       1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RS       6.00       0.00   50000.00   70000.00  100000.00  150832.00  200000.00      -0.00      -0.00      -0.00
RQ       6.00    5000.00    6000.00    7000.00    8000.00  100000.00  200000.00      -0.00      -0.00      -0.00

CP       1.00    6000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID RESERVOIR A (CP 1)                            -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       1.00       2.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

CP       2.00   21000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 2                                          -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       2.00       4.00        .20        .10       5.00      -0.00      -0.00      -0.00      -0.00      -0.00

RL       3.00  100000.00      -0.00       0.00  100000.00  755408.00 1000000.00      -0.00      -0.00      -0.00
RO       1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RS       7.00       0.00  100000.00  200000.00  400000.00  700000.00  800000.00 1000000.00      -0.00      -0.00
RQ       7.00   10000.00   12000.00   18000.00   30000.00   80000.00  150000.00  300000.00      -0.00      -0.00

CP       3.00   12000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID RESERVOIR C (CP 3)                            -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       3.00       4.00        .20        .10       5.00      -0.00      -0.00      -0.00      -0.00      -0.00

CP       4.00   65000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00        .06       2.00
ID CP 4                                          -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       4.00       5.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00
QS       1.00   65000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
CS   65000.00    3420.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DA       1.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DB       1.00     696.82      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DF      17.00       1.00        .90        .80        .70        .60        .50        .40        .30        .25
DF        .20        .15        .10        .05        .02        .01        .01        .00      -0.00      -0.00
DQ      17.00   28800.00   35000.00   42000.00   50500.00   60500.00   73000.00   90000.00  114000.00  130000.00
DQ  150000.00  180000.00  230000.00  323000.00  490000.00  640000.00  840000.00 1000000.00      -0.00      -0.00
DC       1.00       0.00       0.00     180.00     380.00     500.00     630.00     900.00    1250.00    1500.00
DC    1930.00    2660.00    5000.00    9400.00   12280.00   13350.00   14150.00   14600.00      -0.00      -0.00
DC       1.00       0.00       0.00       0.00       0.00       0.00     200.00     300.00     500.00     600.00
DC    1800.00    1100.00    2150.00    9600.00   12280.00   13350.00   14150.00   18600.00      -0.00      -0.00

CP       5.00   37000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 5                                          -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       5.00       0.00       0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ED      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00

     NRES=    2  NCPT=    5  NCPTR=    -0

IN     1  6 JUNE    1000.0    2000.0    3000.0   18000.0   37000.0   42000.0   50000.0   27000.0   20000.0   13000.0
```

Channel Modifications
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		5000,0	4000,0	3000,0	2000,0	1000,0	1000,0	1000,0	1000,0			
											SUM=	231000
IN	2 6 JUNE	2000,0	3000,0	4000,0	6000,0	20000,0	57000,0	100000,0	90000,0	70000,0	50000,0	
		37000,0	24000,0	24000,0	15000,0	9000,0	3000,0	2000,0	1500,0			
											SUM=	517500
IN	3 6 JUNE	3000,0	6000,0	27000,0	60000,0	105000,0	78000,0	60000,0	45000,0	33000,0	24000,0	
		18000,0	12000,0	12000,0	9000,0	6000,0	3000,0	2000,0	1000,0			
											SUM=	504000
IN	4 6 JUNE	2000,0	4000,0	19000,0	13000,0	10000,0	7000,0	4000,0	1000,0	1000,0	4000,0	
		10000,0	25000,0	13000,0	7000,0	4000,0	2000,0	1000,0	500,0			
											SUM=	127500
IN	5 6 JUNE	1000,0	2000,0	9000,0	6000,0	5000,0	3000,0	2000,0	500,0	500,0	2000,0	
		5000,0	12000,0	6000,0	4000,0	2000,0	1000,0	500,0	200,0			
											SUM=	61700
EJ	-0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0			

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SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850.00	3850.00	3850.00	3850.00	.02	2.05	53018.24
5	8400.00	8400.00	8400.00	8400.00	.02	2.01	108479.46

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	Q SPACE	Q BY US	FLOOD BY
2	8625.00	12474.98	12474.56	8525.44	3849.56	1184.09
4	10754.16	23027.84	23018.47	41981.53	12264.32	0.00
5	11795.81	24000.87	24016.26	12983.74	12220.45	1184.98

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRD= 1 NFLCUN= 6
IFLRD = 1 IFLCUN= 2
FLOWS MULTIPLIED BY 1.00

****

**** LOC 1 RESERVOIR A (CP 1) SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 0,MON= 0,YEAR=19 0,

SERVING 1 4

PER	CUM LOCAL Q									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12033.333 MAX= 50000.000
MIN= 1000.000

PER	NATURAL FLOW									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12033.333 MAX= 50000.000
MIN= 1000.000

PER	INFLOW									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12033.333 MAX= 50000.000
MIN= 1000.000

PER	OUTFLOW									
1	1000	2000	3000	6000	0	0	0	0	0	0
11	2650	4000	6000	6000	6000	6000	6000	6000		

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AVG= 3030.500 MAX= 6000.000
MIN= 0.000

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```
PER        CASE=LOC,TYP

  1    .03    .03    .03    .01   4.02   4.01   4.00   4.00   4.00   4.00
 11    .08    .08    .01    .01    .01    .01    .01    .01

                                                            AVG=     1.348  MAX=      4.020
                                                                            MIN=       .010
PER        LEVEL

  1  2.000  2.000  2.000  2.059  2.241  2.448  2.693  2.826  2.925  2.980
 11  3.000  3.000  2.985  2.966  2.941  2.916  2.892  2.867

                                                            AVG=     2.653  MAX=      3.000
                                                                            MIN=      2.000
PER        EOP STORAGE

  1  50000  50000  50000  55950  74298  95125 119918 133307 143224 149671
 11 150832 150832 149344 147361 144881 142402 139923 137443

                                                            AVG= 115806.264 MAX= 150832.000
                                                                            MIN=  50000.000
**************************************************************************************************
**** LOC    2  CP 2                       SERVED BY   -1

PER        CUM LOCAL Q

  1   2000   3000   4000   6000  20000  57000 100000  90000  70000  50000
 11  37000  24000  24000  15000   9000   3000   2000   1500

                                                            AVG=  28750.000 MAX= 100000.000
                                                                            MIN=   1500.000
PER        NATURAL FLOW

  1   3000   4167   6028  11338  39056  91843 142140 134857  98869  70302
 11  49884  30147  28191  18032  11005   4168   3028   2505

                                                            AVG=  41583.282 MAX= 142140.456
                                                                            MIN=   2508.456
PER        REGULATED FLOW

  1   3000   4167   6028   9338  24556  57759 100127  90021  70004  50001
 11  37443  26513  28085  20681  14947   8991   7999   7500

                                                            AVG=  31508.805 MAX= 100126.565
                                                                            MIN=   3000.000
PER        Q SPACE AVAIL.

  1  18000  16833  14972  11662  -3356 -38759 -79127 -69021 -49008 -29001
 11 -10443  -5513  -7085    319   6053  12009  13001  13500

                                                            AVG= -10508.805 MAX=  18000.000
                                                                            MIN= -79126.565
PER        Q BY US RES,DIVS

  1   1000   1167   2028   3338   4556    759    127     21      4      1
 11    443   2513   4085   5681   5947   5991   5999   6000

                                                            AVG=   2758.805 MAX=   5999.758
                                                                            MIN=       .586
PER        FLOOD BY RES

  1      0      0      0      0   3556    759    127     21      4      1
 11    443   2513   4085      0      0      0      0      0

                                                            AVG=    639.385 MAX=   4085.469
```

```
                                                                                                MIN=      0,000
**************************************************************************************************************
**** LOC     3  RESERVOIR C (CP 3)                 SERVED BY     2

                                                                              STARTING TIME=      1
                                          SERVING       2    4                HOUR=12,DAY= 4,MON= 0,YEAR=19 6,
PER        CUM LOCAL Q

    1     3000     6000    27000    60000   105000    78000    60000    45000    33000    24000
   11    18000    12000    12000     9000     6000     3000     2000     1000

                                                                              AVG=  28000,000  MAX= 105000,000
PER        NATURAL FLOW                                                                         MIN=   1000,000

    1     3000     6000    27000    60000   105000    78000    60000    45000    33000    24000
   11    18000    12000    12000     9000     6000     3000     2000     1000

                                                                              AVG=  28000,000  MAX= 105000,000
PER        INFLOW                                                                               MIN=   1000,000

    1     3000     6000    27000    60000   105000    78000    60000    45000    33000    24000
   11    18000    12000    12000     9000     6000     3000     2000     1000

                                                                              AVG=  28000,000  MAX= 105000,000
PER        OUTFLOW                                                                              MIN=   1000,000

    1     3000     6000    12000    12000        0        0        0        0        0        0
   11        0        0    12000    12000    12000    12000    12000    12000

                                                                              AVG=   5833,333  MAX=  12000,000
PER        CASE=LOC,TYP                                                                         MIN=      0,000

    1      ,03      ,03      ,01      ,01     4,02     4,01     4,00     4,00     4,00     4,00
   11     4,01     4,00      ,01      ,01      ,01      ,01      ,01      ,01

                                                                              AVG=      1,788  MAX=      4,020
PER        LEVEL                                                                                MIN=       ,010

    1    2,000    2,000    2,011    2,048    2,127    2,186    2,232    2,266    2,291    2,309
   11    2,322    2,331    2,331    2,329    2,325    2,318    2,310    2,302

                                                                              AVG=      2,224  MAX=      2,331
PER        EOP STORAGE                                                                          MIN=      2,000

    1   100000   100000   107438   131240   183307   221985   251738   274052   298816   308317
   11   311243   317193   317193   315706   312730   308267   303309   297850

                                                                              AVG= 286999,389  MAX= 317193,250
                                                                                                MIN= 100000,000
**************************************************************************************************************
                                                            4
**** LOC     4  CP 4                               SERVED BY     1     2

PER        CUM LOCAL Q

    1     4000     6333    22200    17507    20368    37407    70015    90870    88307    69998
   11    58866    60040    39208    28842    18288    10058     4678     2669
```

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```
                                                                              AVG=  35047.190  MAX=  90869.611
                                                                                               MIN=   2660.973
PER        NATURAL FLOW

   1    8000   11389   36231   55639   99836  148808  170008  190285  166727  130090
  11  101853   89099   58886   43944   29672   17459    9113    5637

                                                                              AVG=  76759.467  MAX= 190284.798
                                                                                               MIN=   5637.126
PER        REGULATED FLOW

   1    8000   11389   31231   30972   31738   42060   71342   91201   84308   70012
  11   39017   61115   45957   43192   35472   27867   22635   20000

                                                                              AVG=  45791.318  MAX=  91201.152
                                                                                               MIN=   8000.000
PER        Q SPACE AVAIL.

   1   57000   53611   33769   34028   33262   22940   -6342  -26201  -19308   -5812
  11    5983    3885   19043   21808   29528   37133   42365   44340

                                                                              AVG=  21200.682  MAX=  57000.000
                                                                                               MIN= -26201.152
PER        Q BY US RES,DIVS

   1    4000    5056    9031   13465   11370    4653    1327     338      77      17
  11     151    1075    6749   14750   17143   17889   17957   17991

                                                                              AVG=   7944.187  MAX=  17990.659
                                                                                               MIN=     17.301
PER        FLOOD BY RES

   1       0       0       0       0       0       0    1327     338      77      17
  11       0       0       0       0       0       0       0       0

                                                                              AVG=     97.411  MAX=   1327.234
                                                                                               MIN=      0.000
****************************************************************************************************************
**** LOC    5  CP 5                        SERVED BY   -1   -2
PER        CUM LOCAL Q

   1    5000    6389   17654   25160   23259   25856   42816   69057   86557   84214
  11   75176   72946   62719   44332   30731   19657   11894    5529

                                                                              AVG=  39319.354  MAX=  86557.190
                                                                                               MIN=   5000.000
PER        NATURAL FLOW

   1    9000   10565   24059   41937   64722  104313  147925  175869  184373  168478
  11  139949  116577   92043   65021   46411   31093   18674   10244

                                                                              AVG=  80269.554  MAX= 184372.522
                                                                                               MIN=   9000.000
PER        REGULATED FLOW

   1    9000   10565   23225   34354   35663   36279   47477   70841   87088   84356
  11   75237   73237   64609   51605   44641   36399   28750   23482

                                                                              AVG=  46487.091  MAX=  87088.368
                                                                                               MIN=   9000.000
PER        Q SPACE AVAIL.

   1   28000   26435   13775    2646    1337     721  -10477  -33841  -50088  -47356
  11  -38237  -36237  -27609  -14605   -7641     601    8250   13558
```

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```
                                                                                          AVG= -9487.091  MAX=  28000.000
                                                                                                          MIN= -50088.364
PER      Q BY US RES,DIVS

  1   8000   4176   5572   9194  12404  10423   5061   1783    531    143
 11     61    290   1890   7273  13909  16742  17656  17913

                                                                                          AVG=  7167.737  MAX=  17912.509
                                                                                                          MIN=     60.603
PER      FLOOD BY RES

  1      0      0      0      0      0      0   5061   1783    531    143
 11     61    290   1890   7273   7641      0      0      0

                                                                                          AVG=  1370.675  MAX=   7640.554
                                                                                                          MIN=      0.000
*********************************************************************************************************************

              CUM TIME=      1

RES NO=          1       3
INFLOW        1000    3000
OUTFLOW       1000    3000
EOP STOR     50000  100000
CASE=          .03     .03
LEVEL        2.000   2.000
EQ LEVEL     2.000   2.000

              CUM TIME=      2

RES NO=          1       3
INFLOW        2000    6000
OUTFLOW       2000    6000
EOP STOR     50000  100000
CASE=          .03     .03
LEVEL        2.000   2.000
EQ LEVEL     2.000   2.000

              CUM TIME=      3

RES NO=          1       3
INFLOW        3000   27000
OUTFLOW       3000   12000
EOP STOR     50000  107438
CASE=          .03     .01
LEVEL        2.000   2.011
EQ LEVEL     2.000   2.011

              CUM TIME=      4

RES NO=          1       3
INFLOW       18000   60000
OUTFLOW       6000   12000
EOP STOR     55950  131240
CASE=          .01     .01
LEVEL        2.059   2.048
EQ LEVEL     2.059   2.048
```

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FALL RIVER BASIN *** CHANNEL MODIFICATIONS ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES
FLOOD SUMMARY=EACH FLOOD COPY= 1

***** FLOOD NUMBER 1 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC 2 CP 2	1.007	35969 *	1.007	82642 *	1.007	30000 *	5969 *	0.00	0.00
LOC 4 CP 4	1.008	45168 *	1.008	57085 *	1.008	27261 *	17907 *	0.00	0.00
LOC 5 CP 5	1.009	43808 *	1.009	55312 *	1.009	25967 *	17841 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	1.018	50000	2.000 *	1.008	61305	2.112 *	1.005	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	1.018	100000	2.000 *	1.008	122016	2.034 *	1.004	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 183321

***** FLOOD NUMBER 2 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC 2 CP 2	2.007	100127 *	2.007	142140 *	2.007	100000 *	127 *	0.00	0.00
LOC 4 CP 4	2.008	91201 *	2.008	190285 *	2.008	90870 *	332 *	0.00	0.00
LOC 5 CP 5	2.009	87088 *	2.009	184373 *	2.009	86557 *	531 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	2.003	50000	2.000 *	2.012	150832	3.000 *	2.004	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	2.002	100000	2.000 *	2.012	317193	2.331 *	2.003	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 468025

***** FLOOD NUMBER 3 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC 2 CP 2	3.007	155287 *	3.007	213211 *	3.007	150000 *	5287 *	0.00	0.00
LOC 4 CP 4	3.009	144615 *	3.008	285427 *	3.008	136304 *	8311 *	0.00	0.00
LOC 5 CP 5	3.010	144668 *	3.009	276559 *	3.009	129836 *	14832 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	3.003	50000	2.000 *	3.007	150832	3.000 *	3.008	80699	6000	50000

```
LOC    3  RESERVOIR C (CP 3)        3,002  100000    2,000 *  3,014  447360    2,530 *  3,003   12000     12000  100000

                    MIN SYSTEM STG=   150000    MAX SYSTEM STG=   598192

                              ***** FLOOD NUMBER  4 *****

                                                                              STARTING TIME      1
                                                                                               SHORTAGE  INDEX
                               FLD,PER  MAX REG Q *   FLD,PER  MAX NAT Q *   FLD,PER  MAX LOC Q * Q BY RES *   DES     REQ
LOC    2  CP 2                  4,008    244438 *      4,007    284281 *      4,007    200000 *   44438 *    0,00    0,00
LOC    4  CP 4                  4,009    222830 *      4,008    380570 *      4,008    181739 *   41091 *    0,00    0,00
LOC    5  CP 5                  4,010    218118 *      4,009    368745 *      4,009    173114 *   45004 *    0,00    0,00
       RESERVOIRS              FLD,PER  MIN STG MIN LEVEL * FLD,PER  MAX STG MAX LEVEL * FLD,PER  MAX REL  CHAN CAP   STOR1
LOC    1  RESERVOIR A (CP 1)    4,003    50000    2,000 *  4,007  150832    3,000 *  4,007   78658      6000   50000
LOC    3  RESERVOIR C (CP 3)    4,002   100000    2,000 *  4,014  573068    2,722 *  4,002   12000     12000  100000
                    MIN SYSTEM STG=   150000    MAX SYSTEM STG=   723896

                              ***** FLOOD NUMBER  5 *****

                                                                              STARTING TIME      1
                                                                                               SHORTAGE  INDEX
                               FLD,PER  MAX REG Q *   FLD,PER  MAX NAT Q *   FLD,PER  MAX LOC Q * Q BY RES *   DES     REQ
LOC    2  CP 2                  5,008    383382 *      5,007    426421 *      5,007    300000 *   83382 *    0,00    0.00
LOC    4  CP 4                  5,009    362013 *      5,008    570854 *      5,008    272609 *   89404 *    0,00    0,00
LOC    5  CP 5                  5,010    355932 *      5,009    553118 *      5,009    259672 *   96261 *    0,00    0,00
       RESERVOIRS              FLD,PER  MIN STG MIN LEVEL * FLD,PER  MAX STG MAX LEVEL * FLD,PER  MAX REL  CHAN CAP   STOR1
LOC    1  RESERVOIR A (CP 1)    5,001    51488    2,015 *  5,007  168236    3,358 *  5,007  120542      6000   50000
LOC    3  RESERVOIR C (CP 3)    5,001   104463    2,007 *  5,011  755408    3,000 *  5,012   35999     12000  100000
                    MIN SYSTEM STG=   155949    MAX SYSTEM STG=   923644

                              ***** FLOOD NUMBER  6 *****

                                                                              STARTING TIME      1
                                                                                               SHORTAGE  INDEX
                               FLD,PER  MAX REG Q *   FLD,PER  MAX NAT Q *   FLD,PER  MAX LOC Q * Q BY RES *   DES     REQ
LOC    2  CP 2                  6,007    510031 *      6,007    508562 *      6,007    400000 *  116031 *    0,00    0,00
LOC    4  CP 4                  6,009    599040 *      6,008    761139 *      6,008    363478 *  235565 *    0,00    0,00
LOC    5  CP 5                  6,010    584434 *      6,009    737490 *      6,009    346229 *  238206 *    0,00    0,00
       RESERVOIRS              FLD,PER  MIN STG MIN LEVEL * FLD,PER  MAX STG MAX LEVEL * FLD,PER  MAX REL  CHAN CAP   STOR1
LOC    1  RESERVOIR A (CP 1)    6,001    51983    2,020 *  6,007  191183    3,821 *  6,007  163829      6000   50000
LOC    3  RESERVOIR C (CP 3)    6,001   105950    2,009 *  6,008  781273    3,106 *  6,009  136168     12000  100000
                    MIN SYSTEM STG=   157933    MAX SYSTEM STG=   972456
```

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES

BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00
EXIST SYSTEM-INPUT	696.82	696.82

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	57085	.632	.615	226.09	226.09	
2	190285	.138	.284	540.14	540.14	
3	285427	.065	.051	357.83	357.83	
4	380570	.036	.026	273.38	273.38	
5	570854	.013	.014	178.59	178.59	
6	761139	.007	.010	145.27	145.27	

BASE COND DAMAGES	1721.30	1721.30
EXST SYST DAMAGES	696.82	696.82

MODIFIED CONDITIONS FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	0.00	0.00	
.7000	50500	0.00	0.00	
.5606	65000	72.00	72.00	
.5000	73000	200.00	200.00	
.4000	90000	300.00	300.00	
.3000	114000	500.00	500.00	
.2500	130000	600.00	600.00	
.2000	150000	1800.00	1800.00	
.1500	180000	1100.00	1100.00	
.1000	230000	2150.00	2150.00	
.0500	323000	9600.00	9600.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	85168	.632	.615	0.00	0.00	
2	91201	.138	.288	48.98	48.98	
3	144615	.065	.051	48.37	48.37	
4	222830	.036	.026	61.41	61.41	
5	362013	.013	.014	127.51	127.51	
6	599048	.007	.010	138.91	138.91	
	MODIFIED DAMAGES			425.18	425.18	
	DAMAGE REDUCTION			271.64	271.64	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	27261	.632	.615	0.00	0.00	
2	90870	.138	.284	33.07	33.07	
3	136304	.065	.051	41.21	41.21	
4	181739	.036	.026	36.88	36.88	
5	272609	.013	.014	57.54	57.54	
6	363478	.007	.010	111.24	111.24	
	DAMAGES W/ TOTAL CONTROL AT PROJECTS			279.95	279.95	
	REDUCTION POSSIBLE W/ TOTAL CONTROL			416.87	416.87	
	RESIDUAL DAMAGES			145.23	145.23	

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Channel Modifications

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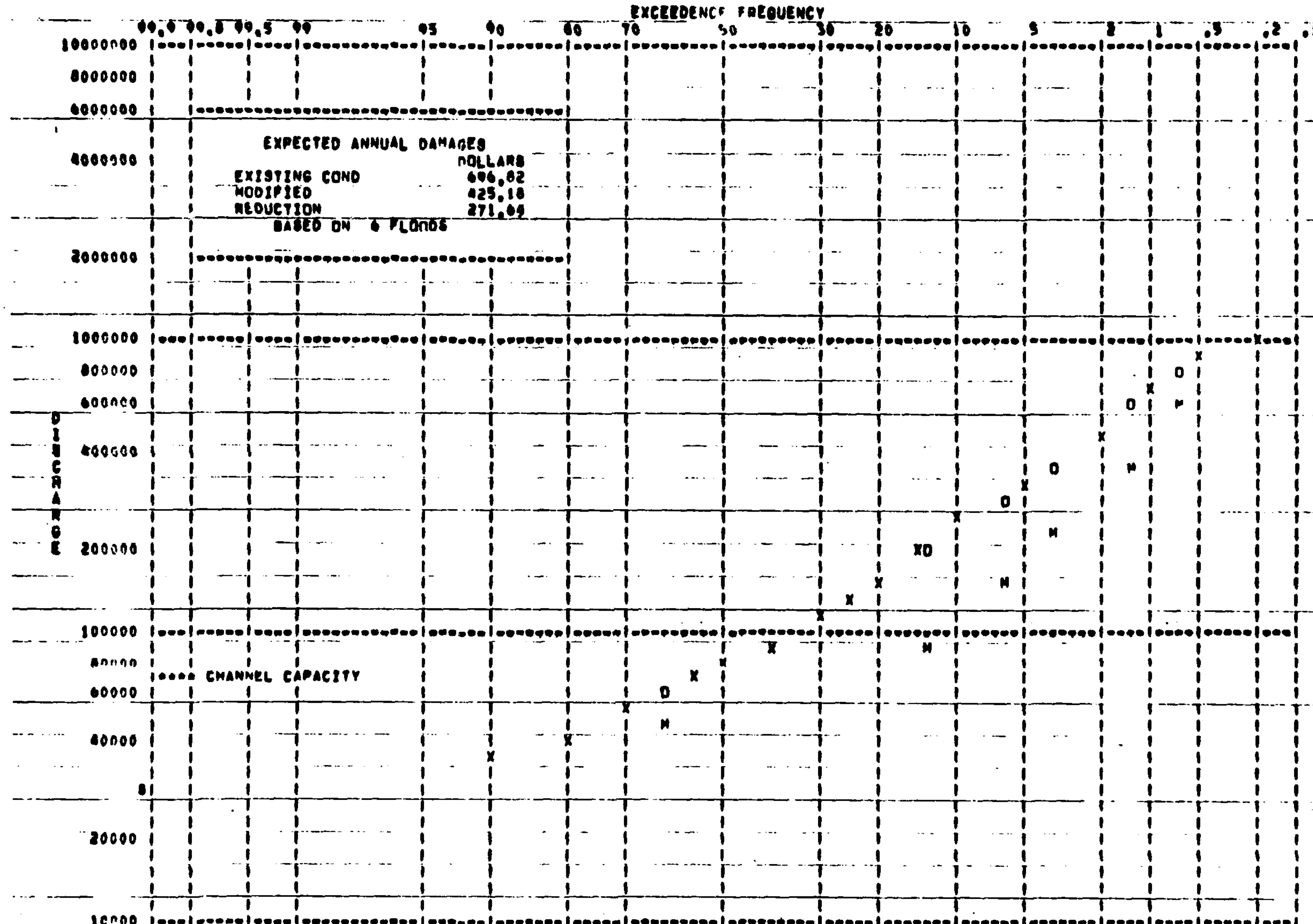
Channel Mod.

CONTROL POINT



O =BASE CONDITION PEAK   M =MODIFIED PEAK   X =INPUT FREQUENCY CURVE $ =BEYOND PLOT RANGE   CONTROL POINT

SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES: BASE (EXIST) CONDITION	DAMAGES: MODIFIED CONDITIONS	DAMAGES: UNCONTROL LOCAL COND	DAMAGE REDUCTION: MODIFIED CONDITIONS	DAMAGE REDUCTION: TOTAL CONTROL AT PROJECTS	DAMAGE REDUCTION: RESIDUAL
8	696.82	425.18	279.95	271.64	416.87	185.23
TOTAL	696.82	425.18	279.95	271.64	416.87	185.23

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Channel Mod.

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Channel Mod.

SYSTEM ECONOMIC COST AND PERFORMANCE SUMMARY
(EXCLUSIVE OF EXISTING SYSTEM COSTS)

TOTAL SYSTEM CAPITAL COST * * * * * * *	3420.00	
TOTAL SYSTEM ANNUAL OPERATING MAINTENANCE, AND REPAIR COST * * * *	66.40	
TOTAL SYSTEM ANNUAL COST * * * * * * *		270.18
AVERAGE ANNUAL DAMAGES - EXISTING SYSTEM	696.82	
AVERAGE ANNUAL DAMAGES - PROPOSED SYSTEM	425.18	
AVERAGE ANNUAL DAMAGE REDUCTION		271.64
AVERAGE ANNUAL SYSTEM NET DAMAGE REDUCTION BENEFITS		1.46

HEC-5C-VARIABLE OUTPUT MAR,1975
RES,= 35 CPTS,= 75 PERS,=100

T1 FALL RIVER BASIN *** DIVERSION ***
T2 TRAINING DOCUMENT NO. 7
T3 FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES

J1	18.00	6.00	4.00	2.00	3.00	-0.00	-0.00	1.00	-0.00	1.00
J2	-0.00	1.10	2.00	1.00	-0.00	0.00	-1.00	-0.00	-0.00	-1.00
J4	6.00	.30	1.00	1.50	2.00	3.00	4.00	-0.00	-0.00	-0.00
RL	1.00	50000.00	-0.00	0.00	50000.00	150832.00	200000.00	-0.00	-0.00	-0.00
RO	1.00	4.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RS	6.00	0.00	56000.00	70000.00	100000.00	150832.00	200000.00	-0.00	-0.00	-0.00
RQ	6.00	5000.00	6000.00	7000.00	8000.00	100000.00	200000.00	-0.00	-0.00	-0.00
CP	1.00	6000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ID RESERVOIR A (CP 1)					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	1.00	2.00	.20	.30	6.00	-0.00	-0.00	-0.00	-0.00	-0.00
CP	2.00	21000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ID CP 2					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	2.00	4.00	.20	.30	6.00	-0.00	-0.00	-0.00	-0.00	-0.00
DR	2.00	5.00	4.20	.15	24.00	.90	-1.00	-0.00	-0.00	-0.00
DQ	9.00	0.00	30000.00	50000.00	70000.00	90000.00	110000.00	130000.00	150000.00	190000.00
DD	9.00	0.00	0.00	22000.00	37500.00	45000.00	51000.00	55000.00	58500.00	62500.00
RL	3.00	100000.00	-0.00	0.00	100000.00	755408.00	1000000.00	-0.00	-0.00	-0.00
RO	1.00	4.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RS	7.00	0.00	100000.00	200000.00	400000.00	700000.00	800000.00	1000000.00	-0.00	-0.00
RQ	7.00	10000.00	12000.00	18000.00	30000.00	80000.00	150000.00	300000.00	-0.00	-0.00
CP	3.00	12000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ID RESERVOIR C (CP 3)					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	3.00	4.00	.20	.30	6.00	-0.00	-0.00	-0.00	-0.00	-0.00
CP	4.00	35000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	.06	.80
ID CP 4					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	4.00	5.00	.20	.30	6.00	-0.00	-0.00	-0.00	-0.00	-0.00
DR	1.00	35000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
CB	35000.00	10520.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
DA	1.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
DB	1.00	696.82	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
DF	17.00	1.00	.90	.80	.70	.60	.50	.40	.30	.25
DF	.20	.15	.10	.05	.02	.01	.01	.00	-0.00	-0.00
DU	17.00	28800.00	35000.00	42000.00	50500.00	60500.00	73000.00	90000.00	114000.00	130000.00
DQ	150000.00	180000.00	230000.00	323000.00	490000.00	640000.00	840000.00	1000000.00	-0.00	-0.00
DC	1.00	0.00	0.00	180.00	380.00	500.00	630.00	900.00	1250.00	1500.00
DC	1930.00	2660.00	5000.00	9900.00	12280.00	13350.00	14150.00	14600.00	-0.00	-0.00
CP	5.00	37000.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ID CP 5					-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
RT	5.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
ED	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

NRES= 2 NCPT= 5 NCPTR= -0

Diversion Data

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Diversion

IN	1	6 JUNE	1000,0	2000,0	3000,0	18000,0	37000,0	42000,0	50000,0	27000,0	20000,0	13000,0		
			5000,0	4000,0	3000,0	2000,0	1000,0	1000,0	1000,0	1000,0				
													SUM=	231000
IN	2	6 JUNE	2000,0	3000,0	4000,0	6000,0	20000,0	57000,0	100000,0	90000,0	70000,0	50000,0		
			37000,0	24000,0	24000,0	15000,0	9000,0	3000,0	2000,0	1500,0				
													SUM=	517500
IN	3	6 JUNE	3000,0	6000,0	27000,0	60000,0	105000,0	78000,0	60000,0	45000,0	33000,0	24000,0		
			18000,0	12000,0	12000,0	9000,0	6000,0	3000,0	2000,0	1000,0				
													SUM=	504000
IN	4	6 JUNE	2000,0	4000,0	19000,0	13000,0	10000,0	7000,0	4000,0	1000,0	1000,0	4000,0		
			10000,0	25000,0	13000,0	7000,0	4000,0	2000,0	1000,0	500,0				
													SUM=	127500
IN	5	6 JUNE	1000,0	2000,0	9000,0	6000,0	5000,0	3000,0	2000,0	500,0	500,0	2000,0		
			5000,0	12000,0	6000,0	4000,0	2000,0	1000,0	500,0	200,0				
													SUM=	61700
EJ	=0		=0,0	=0,0	=0,0	=0,0	=0,0	=0,0	=0,0	=0,0				

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Diversion

SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850.00	3850.00	3850.00	3850.00	.02	2.04	53818.24
3	8400.00	8400.00	8400.00	8034.61	1.12	2.03	119539.16

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	0 SPACE	0 BY US	FLOOD BY
2	8625.68	12474.98	11926.81	9873.19	3301.81	556.33
4	10755.92	23035.43	21408.91	13531.09	10712.99	0.00
5	11795.97	24083.97	21977.37	15022.63	10101.40	0.00

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRD= 1 NFLCUN= 6
IFLAD = 1 IFLCUN= 2
FLOWS MULTIPLIED BY 1.00

****

**** LOC 1 RESERVOIR A (CP 1) SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 0,YEAR=19 0,

SERVING 1 4

PER CUM LOCAL 0

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER NATURAL FLOW

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER INFLOW

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER OUTFLOW

1	1000	2000	3000	6000	0	0	0	0	0	0
11	2650	4000	3000	2000	6000	6000	6000	6000		

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AVG= 2687.691 MAX= 6000.000
MIN= 0.000

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```
PER       CASE=LOC,TYP

     1    .03    .03    .03    .01   4.02   4.01   4.00   4.00   4.00   4.00
    11    .04    .04    .04    .04    .01    .01    .01    .01
                                                                                AVG=     1.352  MAX=      4.020
                                                                                                MIN=       .010
PER       LEVEL

     1  2.000  2.000  2.000  2.059  2.241  2.448  2.693  2.826  2.928  2.988
    11  3.000  3.000  3.000  3.000  2.975  2.951  2.926  2.902
                                                                                AVG=     2.663  MAX=      3.000
                                                                                                MIN=      2.000
PER       EOP STORAGE

     1  50000  50000  50000  55950  74298  95125 119918 133307 143224 149671
    11 150832 150832 150832 150832 148353 145873 143394 140914
                                                                                AVG= 116853.111 MAX= 150832.000
                                                                                                MIN=  50000.000
************************************************************************************************************
**** LOC     2  CP 2                         SERVED BY    =1

PER       CUM LOCAL Q

     1   2000   3000   4000   6000  20000  57000 100000  90000  70000  50000
    11  37000  24000  24000  15000   9000   3000   2000   1500
                                                                                AVG=  28756.000 MAX= 100000.000
                                                                                                MIN=   1500.000
PER       NATURAL FLOW

     1   3000   4167   6028  11338  39096  91863 142140 134897  98809  70302
    11  49884  30147  28191  18032  11005   4160   3028   2505
                                                                                AVG=  41583.282 MAX= 142140.454
                                                                                                MIN=   2504.650
PER       DIVERSION Q

     1      0      0      0      0      0  28014  48038  49006  37501  22000
    11   8187      0      0      0      0      0      0      0
                                                                                AVG=  10485.949 MAX=  48037.969
                                                                                                MIN=      0.000
PER       REGULATED FLOW

     1   3000   4167   6028   9338  24596  29746  52089  45815  32502  28000
    11  29256  26513  27585  17931  11822   8470   7912   7485
                                                                                AVG=  20634.127 MAX=  52088.595
                                                                                                MIN=   3000.000
PER       Q SPACE AVAIL.

     1  18000  16833  14972  11662  -3556  -8746 -31089 -24015 -11502  -7000
    11  -8256  -5513  -6585   3069   9178  12530  13088  13515
                                                                                AVG=   365.873  MAX=  18000.000
                                                                                                MIN= -31088.595
PER       Q BY US RES,DIVS

     1   1000   1167   2028   3338   4556 -27254 -47911 -44985 -37408 -22000
    11  -7744   2513   3585   2931   2822   5470   5912   5985
                                                                                AVG= -8115.873  MAX=   5985.286
```

```
                                                                                                        MIN= -47911.405
PER       FLOOD BY RES

  1        0       0       0       0    3596  -27254  -47911  -48965  -37498  -22000
 11    -7784    2513    3585       0       0       0       0       0
                                                                        AVG=  -9874.382  MAX=   3585.469
                                                                                         MIN= -47911.405
************************************************************************************************************

**** LOC    3  RESERVOIR C (CP 3)                 SERVED BY    2

                                                                        STARTING TIME=     1
                                                                        HOUR=12,DAY= 0,MON= 0,YEAR=19 0,
                                      SERVING      2    0
PER       CUM LOCAL Q

  1     3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
 11    18000   12000   12000    9000    6000    3000    2000    1000
                                                                        AVG=  28000.000  MAX= 105000.000
                                                                                         MIN=   1000.000
PER       NATURAL FLOW

  1     3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
 11    18000   12000   12000    9000    6000    3000    2000    1000
                                                                        AVG=  28000.000  MAX= 105000.000
                                                                                         MIN=   1000.000
PER       INFLOW

  1     3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
 11    18000   12000   12000    9000    6000    3000    2000    1000
                                                                        AVG=  28000.000  MAX= 105000.000
                                                                                         MIN=   1000.000
PER       OUTFLOW

  1     3000    6000   12000   11380       0       0       0       0       0       0
 11        0       0       0       0   12000   12000   12000   12000
                                                                        AVG=   4405.540  MAX=  12000.000
                                                                                         MIN=      0.000
PER       CASE=LOC,TYP

  1      .03     .03     .01    4.02    4.02    4.01    4.00    4.00    4.00    4.00
 11     4.00    4.00    4.00    4.00     .01     .01     .01     .01
                                                                        AVG=      2.453  MAX=      4.020
                                                                                         MIN=       .010
PER       LEVEL

  1    2.000   2.000   2.011   2.048   2.128   2.187   2.232   2.266   2.291   2.309
 11    2.323   2.332   2.341   2.348   2.343   2.336   2.329   2.321
                                                                        AVG=      2.230  MAX=      2.348
                                                                                         MIN=      2.000
PER       EOP STORAGE

  1   100000  100000  107438  131548  183615  222293  252045  274360  290724  302625
 11   311550  317501  323451  327914  324939  320476  315517  310063
                                                                        AVG= 250892.066  MAX= 327914.138
                                                                                         MIN= 100000.000
************************************************************************************************************
```

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**** LOC 4 CP 4 SERVED BY 1 2

PER CUM LOCAL Q

PER										
1	4000	6167	22028	17171	18029	31171	62695	92449	87908	73485
11	61081	62180	39197	29866	19311	11092	4842	2724		

AVG= 35853,070 MAX= 92449,206 MIN= 2723,662

PER NATURAL FLOW

PER										
1	8000	10694	32398	49141	87592	144277	173798	194036	175045	136597
11	106281	93327	59185	45997	31345	19891	9465	5847		

AVG= 76784,776 MAX= 194036,091 MIN= 5846,858

PER REGULATED FLOW

PER										
1	8000	10694	29898	30288	30746	31773	36644	48669	44372	37563
11	39137	53779	40069	32890	24239	24066	21743	20479		

AVG= 31428,330 MAX= 53778,693 MIN= 8000,000

PER Q SPACE AVAIL.

PER										
1	27000	24306	5102	4712	4214	3207	-1644	-13669	-9372	-2563
11	-8137	-18779	-5069	2110	10761	10334	13257	14521		

AVG= 3571,662 MAX= 27000,000 MIN= -18778,693

PER Q BY US RES,DIVS

PER										
1	8000	4528	7870	13117	12747	421	-26051	-43780	-43537	-35921
11	-21944	-8401	873	3024	4928	13414	16901	17756		

AVG= -4424,733 MAX= 17755,560 MIN= -43780,328

PER FLOOD BY RES

PER										
1	0	0	0	0	0	0	-26051	-43780	-43537	-35921
11	-21944	-8401	873	0	0	0	0	0		

AVG= -9931,236 MAX= 872,549 MIN= -43780,324

****

**** LOC 5 CP 5 SERVED BY -1 -2

PER CUM LOCAL Q

PER										
1	5600	6361	17509	24965	22613	23150	36588	63470	87279	87316
11	78309	75315	64539	44865	31940	20706	11959	5792		

AVG= 39319,888 MAX= 87316,106 MIN= 5000,000

PER NATURAL FLOW

PER										
1	9000	10449	22937	38112	57711	94226	142355	172097	187631	172652
11	142220	121279	96295	66172	48252	32794	20104	10752		

AVG= 80279,898 MAX= 187631,160 MIN= 9000,000

PER DIVERSION Q

PER										
1	0	0	0	0	0	-0	0	-6	27	27
11	-209	-849	-1967	-3494	-5246	-6987	-8523	-9730		

AVG= -2053.285 MAX= 26.704
MIN= -9730.180

PER REGULATED FLOW

1	9000	10449	22521	33234	34062	33000	34435	30453	46639	45509
11	44030	54674	57419	47931	39953	33789	33378	31898		

AVG= 36199.571 MAX= 57418.767
MIN= 9000.000

PER Q SPACE AVAIL.

1	28000	26551	14479	3766	2138	3200	2565	-1455	-9639	-8509
11	-7030	-17374	-20419	-10931	-2953	3291	3622	9102		

AVG= 800.429 MAX= 28000.000
MIN= -20418.767

PER Q BY US RES,DIVS

1	4000	4088	5012	8268	12249	10450	-2155	-25017	-40640	-41807
11	-34359	-20942	-7120	3066	8612	13083	21419	26166		

AVG= -3128.317 MAX= 26106.189
MIN= -41806.829

PER FLOOD BY RES

1	0	0	0	0	0	0	0	-25017	-40680	-41807
11	-34359	-20942	-7120	3066	2953	0	0	0		

AVG= -9103.718 MAX= 3065.673
MIN= -41806.829

****

CUM TIME= 1

RES NO=	1	3
DIV Q	-1000	-1000
INFLOW	1000	3000
OUTFLOW	1000	3000
EOP STOR	50000	100000
CASE=	.03	.03
LEVEL	2.000	2.000
EQ LEVEL	2.000	2.000

CUM TIME= 2

RES NO=	1	3
DIV Q	-1000	-1000
INFLOW	2000	6000
OUTFLOW	2000	6000
EOP STOR	50000	100000
CASE=	.03	.03
LEVEL	2.000	2.000
EQ LEVEL	2.000	2.000

CUM TIME= 3

RES NO=	1	3
DIV Q	-1000	-1000
INFLOW	3000	27000

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Diversion

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FALL RIVER BASIN *** DIVERSION ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .5 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES
FLOOD SUMMARY=EACH FLOOD COPY= 1

***** FLOOD NUMBER 1 *****

STARTING TIME 1

		FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REG
LOC	2 CP 2	1.008	29701 *	1.007	42642 *	1.007	30000 *	-299 *	0.00	0.00
LOC	4 CP 4	1.011	33167 *	1.008	58211 *	1.008	27735 *	5433 *	0.00	0.00
LOC	5 CP 5	1.012	35946 *	1.009	56289 *	1.010	26195 *	9751 *	0.00	0.00

	RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	1.018	50000	2.000 *	1.008	61305	2.112 *	1.005	6000	6000	50000
LOC	3 RESERVOIR C (CP 3)	1.003	100000	2.000 *	1.009	138256	2.058 *	1.004	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 199561

***** FLOOD NUMBER 2 *****

STARTING TIME 1

		FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REG
LOC	2 CP 2	2.007	52089 *	2.007	142140 *	2.007	100000 *	-47911 *	0.00	0.00
LOC	4 CP 4	2.012	53779 *	2.008	194036 *	2.008	92449 *	-38671 *	0.00	0.00
LOC	5 CP 5	2.013	57419 *	2.009	107631 *	2.010	87316 *	-29897 *	0.00	0.00

	RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	2.003	50000	2.000 *	2.012	150832	3.000 *	2.004	6000	6000	50000
LOC	3 RESERVOIR C (CP 3)	2.002	100000	2.000 *	2.018	327914	2.348 *	2.003	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 478746

***** FLOOD NUMBER 3 *****

STARTING TIME 1

		FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REG
LOC	2 CP 2	3.007	97999 *	3.007	213211 *	3.007	150000 *	-52001 *	0.00	0.00
LOC	4 CP 4	3.009	92719 *	3.008	291054 *	3.008	138678 *	-45955 *	0.00	0.00
LOC	5 CP 5	3.010	93466 *	3.009	281447 *	3.010	130974 *	-37509 *	0.00	0.00

	RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	3.001	50744	2.007 *	3.007	150832	3.000 *	3.008	40499	6000	50000

LOC	3	RESERVOIR C (CP 3)	3,001	102231	2,003 *	3,015	669191	2,563 *	3,016	12000	12000	100000

MIN SYSTEM STG= 152974 MAX SYSTEM STG= 620023

***** FLOOD NUMBER 4 *****

STARTING TIME 1

			FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	4,008	103991 *	4,007	204201 *	4,007	200000 *	-16009 *	0.00	0.00
LOC	4	CP 4	4,009	170999 *	4,008	388072 *	4,008	188895 *	-13899 *	0.00	0.00
LOC	5	CP 5	4,010	164786 *	4,009	375262 *	4,010	174632 *	-9886 *	0.00	0.00

		RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	4,001	50992	2,010 *	4,007	150832	3,000 *	4,007	96656	6000	50000
LOC	3	RESERVOIR C (CP 3)	4,001	102975	2,005 *	4,015	593091	2,754 *	4,016	12000	12000	100000

MIN SYSTEM STG= 153966 MAX SYSTEM STG= 784723

***** FLOOD NUMBER 5 *****

STARTING TIME 1

			FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	5,008	301544 *	5,007	426421 *	5,007	300000 *	1544 *	0.00	0.00
LOC	4	CP 4	5,009	291948 *	5,008	582100 *	5,008	277348 *	14593 *	0.00	0.00
LOC	5	CP 5	5,010	286931 *	5,009	562893 *	5,010	261988 *	24903 *	0.00	0.00

		RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	5,001	51488	2,015 *	5,007	168236	3,354 *	5,007	120542	6000	50000
LOC	3	RESERVOIR C (CP 3)	5,001	104463	2,007 *	5,011	753468	3,000 *	5,012	35999	12000	100000

MIN SYSTEM STG= 155949 MAX SYSTEM STG= 983640

***** FLOOD NUMBER 6 *****

STARTING TIME 1

			FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	REQ
LOC	2	CP 2	6,007	420928 *	6,007	568562 *	6,007	400000 *	20928 *	0.00	0.00
LOC	4	CP 4	6,009	519662 *	6,008	776184 *	6,008	369797 *	149865 *	0.00	0.00
LOC	5	CP 5	6,010	504091 *	6,009	750525 *	6,010	349264 *	154826 *	0.00	0.00

		RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1	RESERVOIR A (CP 1)	6,001	51983	2,020 *	6,007	191183	3,021 *	6,007	163829	6000	50000
LOC	3	RESERVOIR C (CP 3)	6,001	105950	2,009 *	6,008	781873	3,106 *	6,009	136160	12000	100000

MIN SYSTEM STG= 157935 MAX SYSTEM STG= 972486

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES		
BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00
EXIST SYSTEM-INPUT	696.82	696.82

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.034	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776144	.007	.010	138.03	138.03	

BASE COND DAMAGES	1721.30	1721.30
EXST SYST DAMAGES	696.82	696.82

MODIFIED CONDITIONS FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	.00	.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	33167	.621	.623	10.64	10.64	
2	53779	.134	.279	80.58	80.58	
3	92719	.062	.050	42.90	42.90	
4	170999	.034	.025	60.84	60.84	
5	291940	.013	.014	95.45	95.45	
6	319662	.007	.010	127.53	127.53	
	MODIFIED DAMAGES			417.95	417.95	
	DAMAGE REDUCTION			278.87	278.87	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	27735	.621	.623	14.43	14.43	
2	92889	.134	.279	166.89	166.89	
3	138678	.062	.050	76.32	76.32	
4	184898	.034	.025	72.39	72.39	
5	277348	.013	.014	87.88	87.88	
6	369797	.007	.010	108.25	108.25	
	DAMAGES W/ TOTAL CONTROL AT PROJECTS			525.75	525.75	
	REDUCTION POSSIBLE W/ TOTAL CONTROL			171.07	171.07	
	RESIDUAL DAMAGES			-107.80	-107.80	

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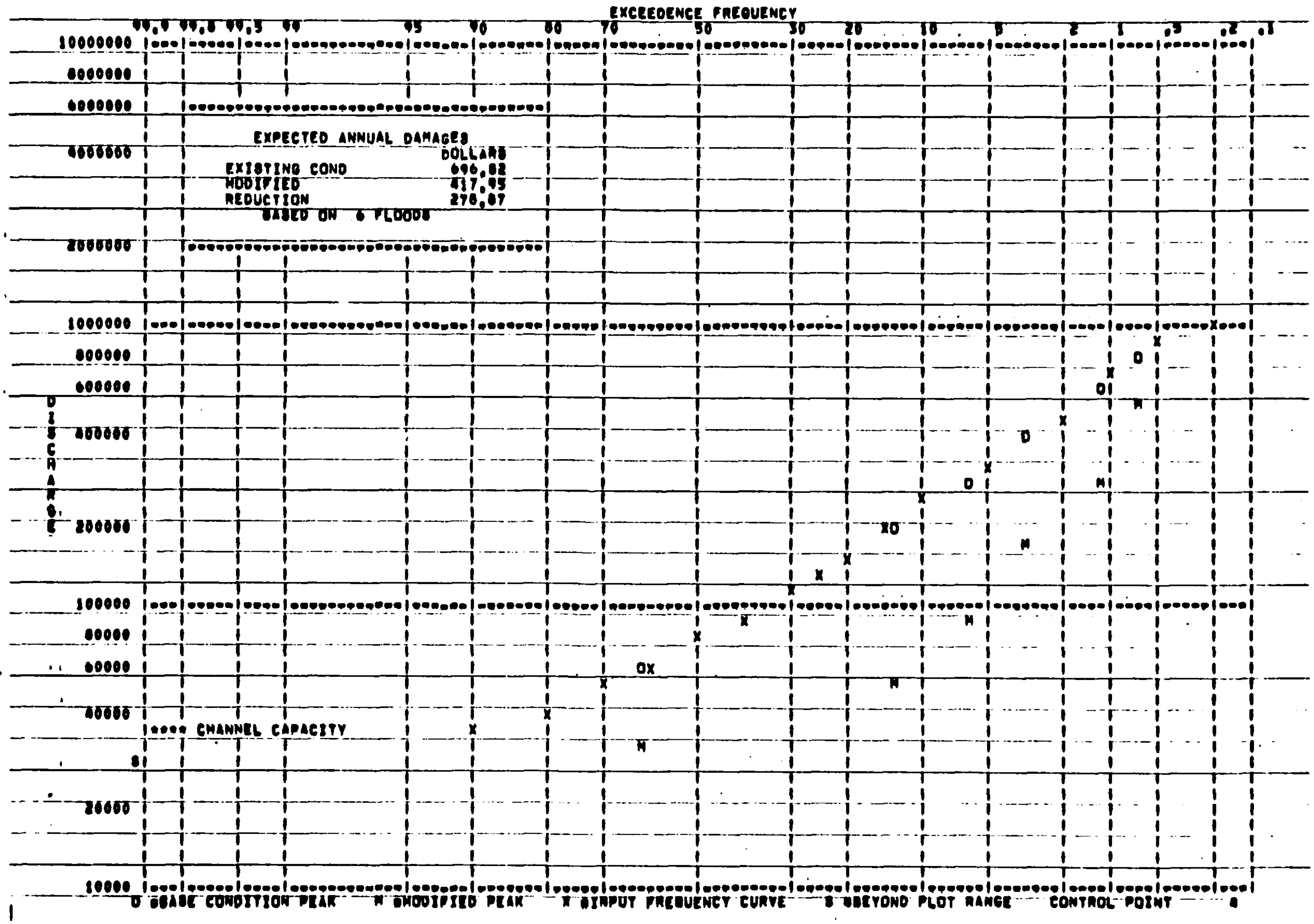
CONTROL POINT 4



SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES			DAMAGE REDUCTION		
	BASE (EXIST) CONDITION	MODIFIED CONDITIONS	UNCONTROL LOCAL COND	MODIFIED CONDITIONS	TOTAL CONTROL AT PROJECTS	RESIDUAL
4	696.82	417.95	525.75	278.87	171.07	-107.80
TOTAL	696.82	417.95	525.75	278.87	171.07	-107.80

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SYSTEM ECONOMIC COST AND PERFORMANCE SUMMARY
(EXCLUSIVE OF EXISTING SYSTEM COSTS)

TOTAL SYSTEM CAPITAL COST	10920.00	
TOTAL SYSTEM ANNUAL OPERATING MAINTENANCE, AND REPAIR COST	84.16	
TOTAL SYSTEM ANNUAL COST		704.84
AVERAGE ANNUAL DAMAGES - EXISTING SYSTEM	696.82	
AVERAGE ANNUAL DAMAGES - PROPOSED SYSTEM	417.95	
AVERAGE ANNUAL DAMAGE REDUCTION		278.87
AVERAGE ANNUAL SYSTEM NET DAMAGE REDUCTION BENEFITS		-425.97

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     HEC-5C-VARIABLE OUTPUT MAR,1975
     RES.= 35 CPTS.= 75 PERS.=100

T1 FALL RIVER BASIN   ***   FLOOD FORECASTING   ***
T2 TRAINING DOCUMENT NO. 7
T3 FLOOD RATIOS .3  1.0  1.5  2.0  3.0  4.0  USED TO COMPUTE ANNUAL DAMAGES
J1        10.00        6.00        4.00        2.00        3.00       -0.00       -0.00        1.00       -0.00        1.00
J2        -0.00        1.15        6.00        1.00       -0.00        0.00       -1.00       -0.00       -0.00       -1.00
J3         6.00         .30        1.00        1.50        2.00        3.00        4.00       -0.00       -0.00       -0.00


RL         1.00    50000.00       -0.00        0.00    50000.00   150832.00   200000.00       -0.00       -0.00       -0.00
RO         1.00        4.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RS         6.00        0.00    50000.00    70000.00   100000.00   150832.00   200000.00       -0.00       -0.00       -0.00
RQ         6.00     5000.00     6000.00     7000.00     8000.00   100000.00   200000.00       -0.00       -0.00       -0.00

CP         1.00     6000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ID RESERVOIR A (CP 1)                                   -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT         1.00        2.00         .20         .30        6.00       -0.00       -0.00       -0.00       -0.00       -0.00

CP         2.00    21000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ID CP 2                                                 -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT         2.00        4.00         .20         .33        6.00       -0.00       -0.00       -0.00       -0.00       -0.00


RL         3.00   100000.00       -0.00        0.00   100000.00   755000.00  1000000.00       -0.00       -0.00       -0.00
RO         1.00        4.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RS         7.00        0.00   100000.00   200000.00   400000.00   700000.00   800000.00  1000000.00       -0.00       -0.00
RQ         7.00    10000.00    12000.00    18000.00    30000.00    80000.00   150000.00   500000.00       -0.00       -0.00

CP         3.00    12000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ID RESERVOIR C (CP 3)                                   -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT         3.00        4.00         .20         .30        6.00       -0.00       -0.00       -0.00       -0.00       -0.00

CP         4.00    35000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00         .06        1.60
ID CP 4                                                 -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT         4.00        5.00         .20         .30        6.00       -0.00       -0.00       -0.00       -0.00       -0.00
QS         1.00    35000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
CS     35000.00      120.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
DA         1.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
DB         1.00      696.82       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
DF        17.00        1.00         .90         .80         .70         .60         .50         .40         .30         .25
DF          .20         .15         .10         .05         .02         .01         .01         .00       -0.00       -0.00
DQ        17.00    28800.00    35000.00    42000.00    50500.00    60500.00    73000.00    90000.00   114000.00   130000.00
DQ    150000.00   180000.00   230000.00   323000.00   490000.00   640000.00   840000.00  1000000.00       -0.00       -0.00
DC         1.00        0.00        0.00      180.00      380.00      500.00      630.00      900.00     1250.00     1500.00
DC      1930.00     2660.00     5000.00     9900.00    12280.00    13350.00    14150.00    14600.00       -0.00       -0.00

CP         5.00    37000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ID CP 5                                                 -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT         5.00        0.00        0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ED        -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00

    NRES=     2  NCPT=    5  NCPTR=    -0

IN     1  6 JUNE   1000.0    2000.0    3000.0   18000.0   37000.0   42000.0   50000.0   27000.0   20000.0   13000.0
                   5000.0    4000.0    3000.0    2000.0    1000.0    1000.0    1000.0    1000.0
                                                                                              SUM=     231000
IN     2  6 JUNE   2000.0    3000.0    4000.0    6000.0   20000.0   57000.0  100000.0   90000.0   70000.0   50000.0
                  37000.0   24000.0   24000.0   15000.0    9000.0    3000.0    2000.0    1500.0
                                                                                              SUM=     517500
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IN	3	6	JUNE	3000.0	6000.0	27000.0	67000.0	105000.0	78000.0	60000.0	45000.0	33000.0	24000.0		
				10000.0	12000.0	12000.0	7000.0	6000.0	3000.0	2000.0	1000.0			SUM=	504000
IN	4	6	JUNE	2000.0	4000.0	19000.0	13000.0	10000.0	7000.0	4000.0	1000.0	1000.0	4000.0		
				10000.0	25000.0	13000.0	7000.0	4000.0	2000.0	1000.0	500.0			SUM=	127500
IN	5	6	JUNE	1000.0	2000.0	9000.0	6000.0	5000.0	3000.0	2000.0	500.0	500.0	2000.0		
				5000.0	12000.0	6000.0	4000.0	2000.0	1000.0	500.0	200.0			SUM=	61700
EJ	-0			-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0				

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SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850.00	3850.00	3850.00	3850.00	.90	2.09	58715.16
3	8400.00	8400.00	8400.00	7911.42	1.12	2.03	121081.52

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	Q SPACE	Q BY US	FLOOD BY
2	8625.00	12474.98	12202.87	8797.13	3577.87	328.84
4	10755.92	23035.43	21319.31	13688.69	10563.39	0.00
5	11795.97	24083.97	21427.36	15572.68	9631.39	0.00

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRO= 1 NFLCON= 6
IFLRO = 1 IFLCUN= 2
FLOWS MULTIPLIED BY 1.00

****

**** LOC 1 RESERVOIR A (CP 1) SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 8,YEAR=19 0,

PER CUM LOCAL Q SERVING 1 4

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

PER NATURAL FLOW AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

PER INFLOW AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

PER OUTFLOW AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

1	0	0	0	0	0	0	0	0	0	9658
11	5000	4000	3000	2000	6000	6000	6000	6000		

PER CASE=LOC,TYP AVG= 2607.691 MAX= 9658.432
MIN= 0.000

1	4.05	4.04	4.03	4.02	4.11	4.05	4.00	4.00	4.00	.04

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   11    .04     .04     .04     .04     .01     .01     .01     .01
                                                                                   AVG=     2.022  MAX=     4.050
                                                                                                   MIN=      .010
PER        LEVEL

    1   2.005   2.015   2.030   2.110   2.300   2.507   2.752   2.885   2.984   3.000
   11   3.000   3.000   3.000   3.000   2.975   2.951   2.926   2.902
                                                                                   AVG=     2.606  MAX=     3.000
                                                                                                   MIN=     2.005
PER        EOP STORAGE

    1   50496   51408   52975   61901   80240  101075  125869  139257  149175  150832
   11  150832  150832  150832  150832  148363  145873  143394  140914
                                                                                   AVG= 119176.604  MAX= 150832.000
                                                                                                    MIN=  50495.875
*************************************************************************************************
**** LOC     2  CP 2                     SERVED BY    =1
PER        CUM LOCAL Q

    1    2000    3000    4000    6000   20000   57000  100000   90000   70000   50000
   11   37000   24000   24000   15000    9000    3000    2000    1500
                                                                                   AVG=  28750.000  MAX= 100000.000
                                                                                                    MIN=   1500.000
PER.       NATURAL FLOW

    1    3000    4167    6028   11338   39056   91843  142140  134857   98809   70302
   11   49884   30147   28191   18032   11065    4168    3028    2505
                                                                                   AVG=  81503.282  MAX= 142140.456
                                                                                                    MIN=   2504.656
PER        REGULATED FLOW

    1    2000    3000    4000    6000   20000   57000  100000   90000   70000   51610
   11   44541   29257   28043   18007   11835    8472    7912    7485
                                                                                   AVG=  31664.520  MAX= 100000.000
                                                                                                    MIN=   2000.000
PER        Q SPACE AVAIL.

    1   19000   18000   17000   15000    1000  -36000  -79000  -69000  -49000  -30610
   11  -23541   -8257   -7043    2993    9165   12528   13088   13515
                                                                                   AVG= [illegible]  MAX=  19000.000
                                                                                                    MIN= -79000.000
PER        Q BY US RES,DIVS

    1       0       0       0       0       0       0       0       0       0    1610
   11    7541    5257    4043    3007    2835    5472    5912    5985
                                                                                   AVG=   2314.820  MAX=   7540.570
                                                                                                    MIN=      0.000
PER        FLOOD BY RES

    1       0       0       0       0       0       0       0       0       0    1610
   11    7541    5257    4043       0       0       0       0       0
                                                                                   AVG=   1024.993  MAX=   7540.570
                                                                                                    MIN=      0.000
*************************************************************************************************
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**** LOC     3  RESERVOIR C (CP 3)                    SERVED BY     2

                                                                                     STARTING TIME=       1
PER        CUM LOCAL Q             SERVING      2    4                               HOUR=12,DAY= 4,MON= 0,YEAR=19 0,

   1    3000     6000    27000    60000   105000    78000    60000    45000    33000    24000
  11   18000    12000    12000     9000     6000     3000     2000     1000

PER        NATURAL FLOW                                                              AVG= 28000.000  MAX= 105000.000
                                                                                                     MIN=   1000.000
   1    3000     6000    27000    60000   105000    78000    60000    45000    33000    24000
  11   18000    12000    12000     9000     6000     3000     2000     1000

PER        INFLOW                                                                    AVG= 28000.000  MAX= 105000.000
                                                                                                     MIN=   1000.000
   1    3000     6000    27000    60000   105000    78000    60000    45000    33000    24000
  11   18000    12000    12000     9000     6000     3000     2000     1000

PER        OUTFLOW                                                                   AVG= 28000.000  MAX= 105000.000
                                                                                                     MIN=   1000.000
   1    3000        0        0        0        0        0        0        0        0        0
  11       0        0        0        0    12000    12000    12000    12000

PER        CASE=LOC,TYP                                                              AVG=  2033.333  MAX=  12000.000
                                                                                                     MIN=      0.000
   1     .03     4.04     4.03     4.02     4.01     4.00     4.00     4.00     4.00     4.00
  11    4.00     4.00     4.00     4.00      .01      .01      .01      .01

PER        LEVEL                                                                     AVG=     2.296  MAX=      4.040
                                                                                                     MIN=       .010
   1   2.000    2.005    2.025    2.070    2.150    2.209    2.254    2.288    2.313    2.331
  11   2.345    2.354    2.363    2.370    2.365    2.359    2.351    2.343

PER        EOP STORAGE                                                               AVG=     2.280  MAX=      2.370
                                                                                                     MIN=      2.000
   1  100000   102975   110368   146116   198103   236461   266614   288920   305292   317195
  11  326119   332069   338020   342483   339508   335045   330086   326631

**********************************************************************************   AVG= 263693.847  MAX= 342482.875
**** LOC     4  CP 4                                                                                 MIN= 100000.000
                                                      SERVED BY     1     2           ***************************
PER        CUM LOCAL Q

   1    4000     6167    22028    17171    18029    31171    62695    92449    87908    73485
  11   61081    62100    39197    29060    19311    11052     4042     2724

PER        NATURAL FLOW                                                              AVG= 35053.070  MAX=  92449.206
                                                                                                     MIN=   2723.662
```

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1	8000	10694	32398	49141	87592	[illegible]	173798	194036	175045	136597
11	106281	93327	59185	45997	31345	[illegible]	9465	5847		

AVG= 76784,776 MAX= 194036,091
MIN= 5846,859

PER REGULATED FLOW

1	7000	8667	22444	17241	18040	31173	62696	92449	87908	73753
11	63455	68479	44425	33934	24466	20713	21752	20481		

AVG= 40170,938 MAX= 92449,260
MIN= 7000,000

PER Q SPACE AVAIL,

1	28000	26333	12556	17759	16960	3827	-27696	-57449	-52908	-38753
11	-28455	-33479	-9325	1066	10534	10287	13248	14519		

AVG= -5170,938 MAX= 28000,000
MIN= -57449,260

PER Q BY US RES,DIVS

1	3000	2500	417	69	12	2	0	0	0	268
11	2375	6299	5228	4068	5155	13461	16910	17757		

AVG= 4317,060 MAX= 17757,346
MIN= ,009

PER FLOOD BY RES

1	0	0	0	0	0	0	0	0	0	268
11	2375	6299	5228	0	0	0	0	0		

AVG= 787,284 MAX= 6298,952
MIN= 0,000

****

**** LOC 5 CP 5 SERVED BY 1 2

PER CUM LOCAL Q

1	5000	6361	17509	24965	22613	23150	36588	63870	87279	87316
11	78389	75315	64539	44865	31940	20706	11959	5792		

AVG= 39319,888 MAX= 87316,106
MIN= 5000,000

PER NATURAL FLOW

1	9000	10849	22937	38112	57711	94226	142355	172097	187631	172652
11	142220	121279	96295	66172	48252	32794	20104	10752		

AVG= 80279,898 MAX= 187631,160
MIN= 9000,000

PER REGULATED FLOW

1	8000	9278	19731	25625	22771	23184	36598	63871	87279	87361
11	78971	78045	70064	49950	36359	27156	24960	22192		

AVG= 42832,985 MAX= 87360,872
MIN= 8000,000

PER Q SPACE AVAIL,

1	29000	27722	17269	11375	14229	13816	404	-26471	-50279	-50361
11	-41971	-41045	-33064	-12950	641	9844	12040	14808		

AVG= -5832,985 MAX= 29000,000
MIN= -50360,872

```
PER        Q BY US RES,DIVS

   1    3880   2917   2222    660    158     34      7      1      0     45
  11     502   2730   5526   5084   4418   6450  13001  16400

                                                                AVG=   3513,097  MAX=  16399,973
                                                                                 MIN=       ,271

PER        FLOOD BY RES

   1       0      0      0      0      0      0      0      1      0     45
  11     502   2730   5526   5084      0      0      0      0

                                                                AVG=    776,024  MAX=   5525,646
                                                                                 MIN=      0,000
*********************************************************************************************************

                 CUM TIME=      1

RES NO=          1        3
INFLOW        1000     3000
OUTFLOW          0     3000
EOP STOR     50496   100000
CASES         4,05      ,03
LEVEL        2,005    2,000
EQ LEVEL     2,005    2,000

                 CUM TIME=      2

RES NO=          1        3
INFLOW        2000     6000
OUTFLOW          0        0
EOP STOR     51488   102975
CASES         4,04     4,04
LEVEL        2,015    2,005
EQ LEVEL     2,015    2,005

                 CUM TIME=      3

RES NO=          1        3
INFLOW        3000    27000
OUTFLOW          0        0
EOP STOR     52975   116364
CASES         4,03     4,03
LEVEL        2,030    2,025
EQ LEVEL     2,030    2,025

                 CUM TIME=      4

RES NO=          1        3
INFLOW       10000    60000
OUTFLOW          0        0
EOP STOR     61901   146116
CASES         4,02     4,02
LEVEL        2,118    2,070
EQ LEVEL     2,118    2,070

                 CUM TIME=      5
```

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FALL RIVER BASIN *** FLOOD FORECASTING ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .5 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES
FLOOD SUMMARY-EACH FLOOD COPY= 1

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***** FLOOD NUMBER 1 *****

STARTING TIME 1

	FLD,PER	MAX REG Q	FLD,PER	MAX NAT Q	FLD,PER	MAX LOC Q	Q BY RES	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC 2 CP 2	1,007	32928	1,007	42642	1,007	30000	2928	0,00	0,00
LOC 4 CP 4	1,012	31779	1,008	58211	1,008	27735	4044	0,00	0,00
LOC 5 CP 5	1,013	32228	1,009	58289	1,010	26195	6034	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL	FLD,PER	MAX STG	MAX LEVEL	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	1,018	50000	2,000	1,010	70647	2,205	1,005	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	1,003	100000	2,000	1,010	142592	2,065	1,008	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 213239

***** FLOOD NUMBER 2 *****

STARTING TIME 1

	FLD,PER	MAX REG Q	FLD,PER	MAX NAT Q	FLD,PER	MAX LOC Q	Q BY RES	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC 2 CP 2	2,007	100000	2,007	142140	2,007	100000	0	0,00	0,00
LOC 4 CP 4	2,008	92449	2,008	190036	2,008	92449	0	0,00	0,00
LOC 5 CP 5	2,010	87361	2,009	187631	2,010	87316	45	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL	FLD,PER	MAX STG	MAX LEVEL	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	2,001	50496	2,005	2,010	150832	3,000	2,010	9650	6000	50000
LOC 3 RESERVOIR C (CP 3)	2,001	100000	2,000	2,014	342482	2,370	2,015	12000	12000	100000

MIN SYSTEM STG= 150495 MAX SYSTEM STG= 493314

***** FLOOD NUMBER 3 *****

STARTING TIME 1

	FLD,PER	MAX REG Q	FLD,PER	MAX NAT Q	FLD,PER	MAX LOC Q	Q BY RES	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC 2 CP 2	3,007	155999	3,007	213211	3,007	150000	5999	0,00	0,00
LOC 4 CP 4	3,008	145356	3,008	291054	3,008	138674	6682	0,00	0,00
LOC 5 CP 5	3,010	144608	3,009	281447	3,010	130974	13633	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL	FLD,PER	MAX STG	MAX LEVEL	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	3,003	48512	1,970	3,008	150832	3,000	3,008	30658	6000	50000
LOC 3 RESERVOIR C (CP 3)	3,001	102231	2,003	3,015	470418	2,565	3,016	12000	12000	100000

MIN SYSTEM STG= 150743 MAX SYSTEM STG= 621250

***** FLOOD NUMBER 4 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	4,008	200290 *	4,007	284281 *	4,007	200000 *	40290 *	0,00	0,00
LOC 4 CP 4	4,009	228588 *	4,008	388072 *	4,008	184898 *	43689 *	0,00	0,00
LOC 5 CP 5	4,010	222512 *	4,009	379262 *	4,010	178632 *	87880 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	4,001	48016	1,960 *	4,007	150832	3,000 *	4,007	72658	6000	50000
LOC 3 RESERVOIR C (CP 3)	4,001	102975	2,005 *	4,015	593891	2,754 *	4,016	12000	12000	100000

MIN SYSTEM STG= 150991 MAX SYSTEM STG= 788723

***** FLOOD NUMBER 5 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	5,008	379020 *	5,007	420821 *	5,007	300000 *	79020 *	0,00	0,00
LOC 4 CP 4	5,009	377567 *	5,008	582108 *	5,008	277348 *	100220 *	0,00	0,00
LOC 5 CP 5	5,010	369489 *	5,009	562893 *	5,010	261948 *	107540 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	5,002	88512	1,970 *	5,007	187318	3,335 *	5,007	118761	6000	50000
LOC 3 RESERVOIR C (CP 3)	5,001	104463	2,007 *	5,012	755408	3,000 *	5,013	35999	12000	100000

MIN SYSTEM STG= 152974 MAX SYSTEM STG= 922722

***** FLOOD NUMBER 6 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	6,007	51[illegible] *	6,007	568562 *	6,007	400000 *	114646 *	0,00	0,00
LOC 4 CP 4	6,009	601840 *	6,008	776184 *	6,008	369797 *	232043 *	0,00	0,00
LOC 5 CP 5	6,010	584478 *	6,009	750525 *	6,010	349264 *	235213 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	6,001	49008	1,980 *	6,007	191183	3,821 *	6,007	163829	6000	50000
LOC 3 RESERVOIR C (CP 3)	6,001	105950	2,009 *	6,009	769930	3,059 *	6,009	128311	12000	100000

MIN SYSTEM STG= 154958 MAX SYSTEM STG= 961113

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES

	SUM	TYPE 1
BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00
EXIST SYSTEM-INPUT	696.82	696.82

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.034	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776144	.007	.010	138.03	138.03	

	SUM	TYPE 1
BASE COND DAMAGES	1721.30	1721.30
EXST SYST DAMAGES	696.82	696.82

MODIFIED CONDITIONS FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	.00	.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1600000	14600.00	14600.00	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	31779	.621	.623	27,97	27,97	
2	92449	.134	.279	174,34	174,34	
3	145356	.062	.050	84,07	84,07	
4	228588	.034	.025	118,78	118,78	
5	377567	.013	.014	136,83	136,83	
6	601840	.007	.010	131,99	131,99	
	MODIFIED DAMAGES			673,97	673,97	
	DAMAGE REDUCTION			22,85	22,85	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	27735	.621	.623	14,43	14,43	
2	92449	.134	.279	166,49	166,49	
3	138674	.062	.050	76,32	76,32	
4	184898	.034	.025	72,39	72,39	
5	277348	.013	.014	87,88	87,88	
6	369797	.007	.010	108,25	108,25	
	DAMAGES W/ TOTAL CONTROL AT PROJECTS			525,75	525,75	
	REDUCTION POSSIBLE W/ TOTAL CONTROL			171,07	171,07	
	RESIDUAL DAMAGES			148,22	148,22	

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CONTROL POINT 8

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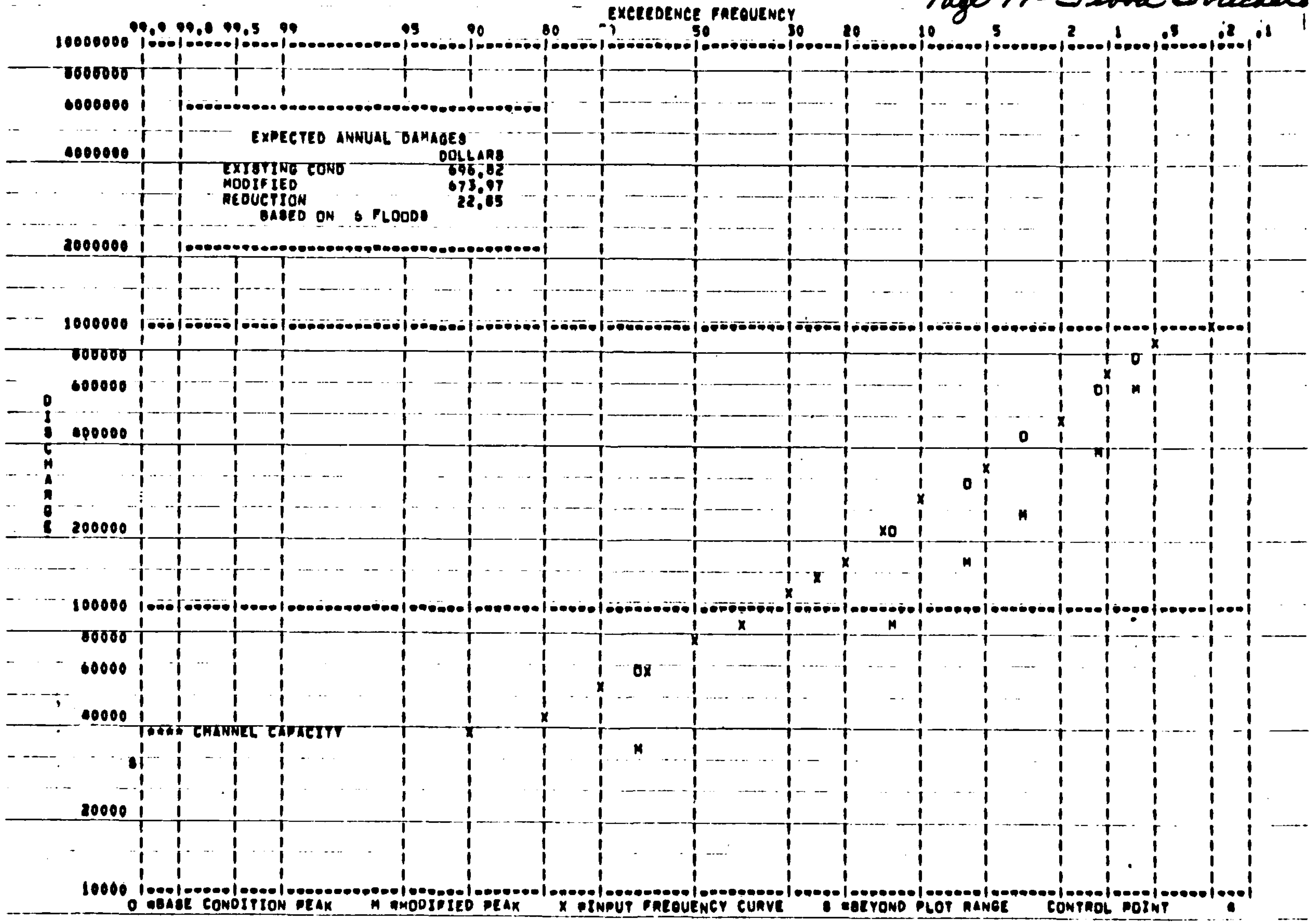

SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES			DAMAGE REDUCTION		
	BASE (EXIST) CONDITION	MODIFIED CONDITIONS	UNCONTROL LOCAL COND	MODIFIED CONDITIONS	TOTAL CONTROL AT PROJECTS	RESIDUAL
4	696,82	673,97	525,75	22,85	171,07	148,22
TOTAL	696,82	673,97	525,75	22,85	171,07	148,22

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SYSTEM ECONOMIC COST AND PERFORMANCE SUMMARY
(EXCLUSIVE OF EXISTING SYSTEM COSTS)

TOTAL SYSTEM CAPITAL COST * * * * * * *	120.00	
TOTAL SYSTEM ANNUAL OPERATING MAINTENANCE, AND REPAIR COST * * * *	1.92	
TOTAL SYSTEM ANNUAL COST * * * * * * *		9.00
AVERAGE ANNUAL DAMAGES - EXISTING SYSTEM	696.82	
AVERAGE ANNUAL DAMAGES - PROPOSED SYSTEM	673.97	
AVERAGE ANNUAL DAMAGE REDUCTION		22.85
AVERAGE ANNUAL SYSTEM NET DAMAGE REDUCTION BENEFITS		13.85

```
     HEC-5C-VARIABLE OUTPUT MAR,1975
     RES,= 35 CPTS,= 75 PERS,=100

  T1 FALL RIVER BASIN   ***   FLOOD PROOFING   ***
  T2 TRAINING DOCUMENT NO. 7
  T3 FLOOD RATIOS .3  1.0  1.5  2.0  3.0  4.0  USED TO COMPUTE ANNUAL DAMAGES
  J1       18.00       6.00       4.00       2.00       3.00      -0.00      -0.00       1.00      -0.00       1.00
  J2       -0.00       1.10       2.00       1.00      -0.00       0.00      -1.00      -0.00      -0.00      -1.00
  J4        6.00        .30       1.00       1.50       2.00       3.00       4.00      -0.00      -0.00      -0.00

  RL        1.00   50000.00      -0.00       0.00   50000.00  150832.00  200000.00      -0.00      -0.00      -0.00
  RO        1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  RS        6.00       0.00   50000.00   70000.00  100000.00  150832.00  200000.00      -0.00      -0.00      -0.00
  RQ        6.00    5000.00    6000.00    7000.00    8000.00  100000.00  200000.00      -0.00      -0.00      -0.00

  CP        1.00    6000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  ID RESERVOIR A (CP 1)                              -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  RT        1.00       2.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

  CP        2.00   21000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  ID CP 2                                            -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  RT        2.00       4.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

  RL        3.00  100000.00      -0.00       0.00  100000.00  755408.00 1000000.00      -0.00      -0.00      -0.00
  RO        1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  RS        7.00       0.00  100000.00  200000.00  400000.00  700000.00  800000.00 1000000.00      -0.00      -0.00
  RQ        7.00   10000.00   12000.00   18000.00   30000.00   80000.00  150000.00  500000.00      -0.00      -0.00

  CP        3.00   12000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  ID RESERVOIR C (CP 3)                              -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  RT        3.00       4.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

  CP        4.00   35000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00        .06        .70
  ID CP 4                                            -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  RT        4.00       5.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00
  DS        1.00   35000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  CS    35000.00    3480.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  DA        1.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  DB        1.00     696.82      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  DF       17.00       1.00        .90        .80        .70        .60        .50        .40        .30        .25
  DF         .20        .15        .10        .05        .02        .01        .01        .00      -0.00      -0.00
  DQ       17.00   28800.00   35000.00   42000.00   50500.00   60500.00   73000.00   90000.00  114000.00  130000.00
  DQ   150000.00  180000.00  230000.00  323000.00  490000.00  640000.00  840000.00 1000000.00      -0.00      -0.00
Existing
  DC        1.00       0.00       0.00     180.00     380.00     500.00     630.00     900.00    1250.00    1500.00
  DC     1930.00    2660.00    3000.00    9900.00   12280.00   13350.00   14150.00   14600.00      -0.00      -0.00
Modified
  DC        1.00       0.00       0.00      90.00     120.00     140.00     150.00     200.00     250.00     300.00
  DC      400.00     700.00    5000.00    9900.00   12280.00   13350.00   14150.00   14600.00      -0.00      -0.00

  CP        5.00   37000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  ID CP 5                                            -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  RT        5.00       0.00       0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
  ED       -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00

      NRES=     2  NCPT=     5  NCPTR=    -0

  IN       1  6 JUNE    1000.0     2000.0     3000.0    18000.0    37000.0    42000.0    50000.0    27000.0    20000.0    13000.0
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Flood Proofing
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```
                5000,0    4000,0    3000,0    2000,0    1000,0    1000,0    1000,0    1000,0
                                                                                                          SUM=     231000
IN   2  6 JUNE  2000,0    3000,0    4000,0    6000,0   20000,0   57000,0  100000,0   90000,0   70000,0   50000,0
               37000,0   24000,0   24000,0   15000,0    9000,0    3000,0    2000,0    1500,0
                                                                                                          SUM=     517500
IN   3  6 JUNF  3000,0    6000,0   27000,0   60000,0  105000,0   78000,0   60000,0   45000,0   33000,0   24000,0
               18000,0   12000,0   12000,0    9000,0    6000,0    3000,0    2000,0    1000,0
                                                                                                          SUM=     504000
IN   4  6 JUNE  2000,0    4000,0   14000,0   13000,0   10000,0    7000,0    4000,0    1000,0    1000,0    4000,0
               10000,0   25000,0   13000,0    7000,0    4000,0    2000,0    1000,0     500,0
                                                                                                          SUM=     127500
IN   5  6 JUNE  1000,0    2000,0    9000,0    6000,0    5000,0    3000,0    2000,0     500,0     500,0    2000,0
                5000,0   12000,0    6000,0    4000,0    2000,0    1000,0     500,0     200,0
                                                                                                          SUM=      61700
EJ  -0             -0,0      -0,0      -0,0      -0,0      -0,0      -0,0      -0,0      -0,0
```

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SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850.00	3850.00	3850.00	3850.00	.90	2.07	57494.67
3	8400.00	8400.00	8400.00	7450.62	1.12	2.03	122385.98

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	Q SPACE	Q BY US	FLOOD BY
2	8425.00	12474.98	12328.87	8671.13	3703.87	476.19
4	10755.92	23035.63	21005.66	13994.34	10289.74	0.00
5	11745.97	24083.97	21119.00	15881.00	9323.04	0.00

COMPUTATION INTERVAL IN HOURS= 6

```
          ***** FLOOD NUMBER  2 *****

     NFLRCX=      1  NFLCON=     6
     IFLRD =      1  IFLCON=     2
        FLOWS MULTIPLIED BY    1.00

**********************************************************************************

**** LOC   1  RESERVOIR A (CP 1)        SERVED BY   1

                                                              STARTING TIME=      1
                                                              HOUR=12,DAY= 0,MON= 0,YEAR=19 0,
                         SERVING    1    4
PER    CUM LOCAL Q

  1  1000  2000  3000  18000  37000  42000  50000  27000  20000  13000
 11  5000  4000  3000   2000   1000   1000   1000   1000

                                                              AVG=  12833.333  MAX=  50000.000
                                                                               MIN=   1000.000
PER    NATURAL FLOW

  1  1000  2000  3000  18000  37000  42000  50000  27000  20000  13000
 11  5000  4000  3000   2000   1000   1000   1000   1000

                                                              AVG=  12833.333  MAX=  50000.000
                                                                               MIN=   1000.000
PER    INFLOW

  1  1000  2000  3000  18000  37000  42000  50000  27000  20000  13000
 11  5000  4000  3000   2000   1000   1000   1000   1000

                                                              AVG=  12833.333  MAX=  50000.000
                                                                               MIN=   1000.000
PER    OUTFLOW

  1  1000  2000  3000      0      0      0      0      0      0   3650
 11  5000  4000  3000   2000   6000   6000   6000   6000

                                                              AVG=   2647.691  MAX=   6000.000
                                                                               MIN=      0.000
```

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```
PER        CASE=LUC.TYP

   1     .03     .03     .03    4.02    4.01    4.00    4.00    4.00    4.00     .04
  11     .04     .04     .04     .04     .01     .01     .01     .01
                                                                              AVG=     1.353  MAX=     4.020
                                                                                              MIN=      .010
PER        LEVEL

   1   2.000   2.000   2.000   2.089   2.270   2.477   2.723   2.856   2.954   3.000
  11   3.000   3.000   3.000   3.000   2.975   2.951   2.926   2.902
                                                                              AVG=     2.673  MAX=     3.000
                                                                                              MIN=     2.000
PER        EUP STORAGE

   1   50000   50000   50000   58926   77273   98166  122894  136282  146200  150832
  11  150832  150832  150832  150832  148353  145873  143394  140914
                                                                              AVG= 117909.368  MAX= 150832.000
                                                                                              MIN=  50000.000
**************************************************************************************************************
**** LOC     2  CP 2                               SERVED BY    =1

PER        CUM LOCAL Q

   1    2000    3000    4000    6000   20000   57000  100000   90000   70000   50000
  11   37000   24000   24000   15000    9000    3000    2000    1500
                                                                              AVG=  28750.000  MAX= 100000.000
                                                                                              MIN=   1500.000
PER        NATURAL FLOW

   1    3000    4167    6028   11338   39056   91843  142140  134857   98009   70302
  11   49884   30147   28191   18032   11065    4168    3028    2505
                                                                              AVG=  41503.282  MAX= 142140.456
                                                                                              MIN=   2504.654
PER        REGULATED FLOW

   1    3000    4167    6028    8338   20390   57065  100011   90002   70000   50610
  11   40374   28562   27927   17988   11811    8472    7912    7485
                                                                              AVG=  31120.076  MAX= 100010.824
                                                                                              MIN=   3000.000
PER        Q SPACE AVAIL.

   1   18000   16833   18972   12662     610  -36065  -79011  -69002  -49000  -29610
  11  -19374   -7562   -6927    3012    9169   12528   13088   13515
                                                                              AVG= -10120.076  MAX=  18000.000
                                                                                              MIN= -79010.824
PER        Q BY US RES,DIVS

   1    1000    1167    2028    2338     390      65      11       2       0     610
  11    3374    4562    3927    2988    2831    5472    5912    5985
                                                                              AVG=   2370.076  MAX=   5985.330
                                                                                              MIN=       .301
PER        FLOOD BY RES

   1       0       0       0       0       0      65      11       2       0     610
  11    3374    4562    3927       0       0       0       0       0
                                                                              AVG=    697.275  MAX=   4562.320
```

```
                                                                                                   MIN=     0.000
*****************************************************************************************************************
**** LOC     3  RESERVOIR C (CP 3)                 SERVED BY    2

                                                                                  STARTING TIME=     1
                                       SERVING      2    4                        HOUR=12,DAY= 4,MON= 0,YEAR=19 0,
PER       CUM LOCAL Q

  1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
 11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                  AVG=  28000.000  MAX= 105000.000
PER       NATURAL FLOW                                                                             MIN=   1000.000

  1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
 11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                  AVG=  28000.000  MAX= 105000.000
PER       INFLOW                                                                                   MIN=   1000.000

  1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
 11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                  AVG=  28000.000  MAX= 105000.000
PER       OUTFLOW                                                                                  MIN=   1000.000

  1    3000    6000   12000       0       0       0       0       0       0       0
 11       0       0       0       0   12000   12000   12000   12000

                                                                                  AVG=   3833.333  MAX=  12000.000
PER       CASE=LOC,TYP                                                                             MIN=      0.000

  1     .03     .03     .01    4.02    4.01    4.00    4.00    4.00    4.00    4.00
 11    4.00    4.00    4.00    4.00     .01     .01     .01     .01

                                                                                  AVG=      2.452  MAX=      4.020
PER       LEVEL                                                                                    MIN=       .010

  1   2.000   2.000   2.011   2.057   2.136   2.195   2.241   2.275   2.300   2.318
 11   2.331   2.340   2.350   2.356   2.352   2.3[illegible]   2.337   2.329

                                                                                  AVG=      2.237  MAX=      2.356
PER       EOP STORAGE                                                                              MIN=      2.000

  1  100000  100000  107438  137191  189247  227936  257688  280003  296366  308267
 11  317193  323188  329094  333557  3305[illegible]  326119  321160  315706

                                                                                  AVG= 255596.556  MAX= 333557.125
                                                                                                   MIN= 100000.000
*****************************************************************************************************************
**** LOC     4  CP 4                               SERVED BY    1    2

PER       CUM LOCAL Q

  1    4000    8167   22028   17171   18029   31171   62695   92449   87900   73485
 11   61081   62180   39197   [illegible]   19311   11052    4842    2724
```

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AVG= 35853,870 MAX= 92849,200
MIN= 2723,662

PER	NATURAL FLOW									
1	8000	10694	32398	49181	87592	144277	173798	194036	175045	136597
11	106281	93327	59185	45997	31355	19091	9465	5847		

AVG= 76784,776 MAX= 198036,091
MIN= 5846,858

PER	REGULATED FLOW									
1	8000	10698	29898	28225	21498	32020	62882	92888	87916	73588
11	62067	65354	43422	33686	24811	24701	21750	28481		

AVG= 41282,055 MAX= 92487,801
MIN= 8000,000

PER	Q SPACE AVAIL.									
1	27000	24306	5102	6775	13506	2980	=27882	=57488	=52916	=38588
11	=27067	=30354	=8322	1314	10589	10299	13250	14519		

AVG= =6282,055 MAX= 27000,000
MIN= =57487,801

PER	Q BY US RES,DIVS									
1	4000	4520	7870	11053	3466	848	186	39	8	103
11	986	3174	4225	3820	5100	13650	16908	17757		

AVG= 5428,084 MAX= 17756,987
MIN= 7,685

PER	FLOOD BY [illegible]									
1	0	0	0	0	0	0	186	39	8	103
11	986	3176	4225	0	0	0	0	0		

AVG= 484,498 MAX= 4225,056
MIN= 0,000

****

**** LOC 5 CP 5 SERVED BY =1 =2

PER	CUM LOCAL Q									
1	5000	6361	17509	24965	22613	23150	36588	63470	87279	87316
11	78389	75315	64539	44865	31940	20706	11959	5792		

AVG= 39319,888 MAX= 87316,106
MIN= 5000,000

PER	NATURAL FLOW									
1	9080	10889	22937	38112	57711	94226	142355	172097	187631	172652
11	142220	121279	96295	66172	44252	32794	20108	10752		

AVG= 80279,898 MAX= 187631,160
MIN= 9080,000

PER	REGULATED FLOW									
1	9000	10849	22521	32890	31880	27146	37851	63811	87363	87352
11	78624	76542	67563	88823	35997	27057	24936	22186		

AVG= 43999,739 MAX= 87363,008
MIN= 9000,000

PER	Q SPACE AVAIL.									
1	28000	26551	14479	4110	5120	9854	=851	=26811	=50363	=50352
11	=81628	=39542	=30563	=11823	1023	9943	12064	14814		

```
                                                                           AVG=  -6999.739  MAX=  28000.000
                                                                                            MIN= -50363.008
 PER       Q BY US RES,DIVS

    1   4000   4068   5012   7924   9267   3996   1263    341     84     36
   11    239   1226   3025   3957   4056   6351  12976  16394
                                                                           AVG=   6679.852  MAX=  16394.320
                                                                                            MIN=     36.200
 PER       FLOOD BY RES

    1      0      0      0      0      0      0    851    341     84     36
   11    239   1226   3025   3957      0      0      0      0
                                                                           AVG=    542.212  MAX=   3957.493
                                                                                            MIN=      0.000
 ****************************************************************************************************

               CUM TIME=      1

 RES NO=        1        3
 INFLOW      1000     3000
 OUTFLOW     1000     3000
 EOP STOR   50000   100000
 CASE=        .03      .03
 LEVEL      2.000    2.000
 EQ LEVEL   2.000    2.000

               CUM TIME=      2

 RES NO=        1        3
 INFLOW      2000     6000
 OUTFLOW     2000     6000
 EOP STOR   50000   100000
 CASE=        .03      .03
 LEVEL      2.000    2.000
 EQ LEVEL   2.000    2.000

               CUM TIME=      3

 RES NO=        1        3
 INFLOW      3000    27000
 OUTFLOW     3000    12000
 EOP STOR   50000   107438
 CASE=        .03      .01
 LEVEL      2.000    2.011
 EQ LEVEL   2.000    2.011

               CUM TIME=      4

 RES NO=        1        3
 INFLOW     18000    60000
 OUTFLOW        0        0
 EOP STOR   58926   137191
 CASE=       4.02     4.02
 LEVEL      2.089    2.057
 EQ LEVEL   2.089    2.057
```

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FALL RIVER BASIN *** FLOOD PROOFING ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES
FLOOD SUMMARY-EACH FLOOD COPY= 1

***** FLOOD NUMBER 1 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	1.007	34777 *	1.007	42642 *	1.007	30000 *	4777 *	0.00	0.00
LOC 4 CP 4	1.012	33134 *	1.008	58211 *	1.008	27735 *	5400 *	0.00	0.00
LOC 5 CP 5	1.012	33586 *	1.009	56289 *	1.010	26195 *	7391 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	1.018	50000	2.000 *	1.008	67393	2.173 *	1.005	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	1.003	100000	2.000 *	1.010	140755	2.062 *	1.004	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 208148

***** FLOOD NUMBER 2 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	2.007	100011 *	2.007	142140 *	2.007	100000 *	11 *	0.00	0.00
LOC 4 CP 4	2.008	92488 *	2.008	194036 *	2.008	92449 *	39 *	0.00	0.00
LOC 5 CP 5	2.009	87363 *	2.009	187631 *	2.010	87316 *	47 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	2.003	50000	2.000 *	2.011	150832	3.000 *	2.015	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	2.002	100000	2.000 *	2.014	333557	2.356 *	2.003	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 484389

***** FLOOD NUMBER 3 *****

STARTING TIME 1

	FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	3.007	157221 *	3.007	213211 *	3.007	150000 *	7221 *	0.00	0.00
LOC 4 CP 4	3.009	150695 *	3.008	291054 *	3.008	138674 *	12022 *	0.00	0.00
LOC 5 CP 5	3.010	150348 *	3.009	281447 *	3.010	130974 *	19374 *	0.00	0.00

RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	3.001	50744	2.007 *	3.007	150832	3.000 *	3.008	40499	6000	50000

LOC	3 RESERVOIR C (CP 3)	3,001	[illegible]	2,003 *	3,015	470818	2,565 *	3,016	12000	12000	100000

MIN SYSTEM STG= [illegible]2076 MAX SYSTEM STG= 621250

***** FLOOD NUMBER 4 *****

STARTING TIME 1

LOC		FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC	2 CP 2	4,008	[illegible]767 *	4,007	284281 *	4,007	200000 *	[illegible] *	[illegible]	[illegible]
LOC	4 CP 4	4,009	[illegible]896 *	4,008	388072 *	4,008	184898 *	[illegible] *	0,00	[illegible]
LOC	5 CP 5	4,010	[illegible]892 *	4,009	375262 *	4,010	174632 *	[illegible] *	0,00	0,00

RESERVOIRS		FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	4,001	50992	2,010 *	4,007	150832	3,000 *	4,007	90658	6000	50000
LOC	3 RESERVOIR C (CP 3)	4,001	102975	2,005 *	4,015	593891	2,754 *	4,016	12000	12000	100000

MIN SYSTEM STG= 153066 MAX SYSTEM STG= 766723

***** FLOOD NUMBER 5 *****

STARTING TIME 1

LOC		FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC	2 CP 2	5,008	303302 *	5,007	426421 *	5,007	300000 *	03302 *	0,00	0,00
LOC	4 CP 4	5,009	372066 *	5,008	582108 *	5,008	277348 *	94718 *	0,00	0,00
LOC	5 CP 5	5,010	365070 *	5,009	562893 *	5,010	261948 *	103121 *	0,00	0,00

RESERVOIRS		FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	5,001	51488	2,015 *	5,007	168236	3,354 *	5,007	120542	6000	50000
LOC	3 RESERVOIR C (CP 3)	5,001	104463	2,007 *	5,011	755400	3,000 *	5,012	35999	12000	100000

MIN SYSTEM STG= 155989 MAX SYSTEM STG= 923644

***** FLOOD NUMBER 6 *****

STARTING TIME 1

LOC		FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC	2 CP 2	6,007	516031 *	6,007	568562 *	6,007	400000 *	116031 *	0,00	0,00
LOC	4 CP 4	6,009	612533 *	6,008	776144 *	6,008	369797 *	242736 *	0,00	0,00
LOC	5 CP 5	6,010	594538 *	6,009	750525 *	6,010	349264 *	245274 *	0,00	0,00

RESERVOIRS		FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	6,001	51983	2,020 *	6,007	191183	3,021 *	6,007	163829	6000	50000
LOC	3 RESERVOIR C (CP 3)	6,001	105950	2,009 *	6,008	781273	3,106 *	6,009	136168	12000	100000

MIN SYSTEM STG= 157933 MAX SYSTEM STG= 972856

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 6

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
,9990	28800	0,00	0,00	
,9000	35000	0,00	0,00	
,8000	42000	180,00	180,00	
,7000	50500	380,00	380,00	
,6000	60500	500,00	500,00	
,5000	73000	630,00	630,00	
,4000	90000	900,00	900,00	
,3000	114000	1250,00	1250,00	
,2500	130000	1500,00	1500,00	
,2000	150000	1930,00	1930,00	
,1500	180000	2660,00	2660,00	
,1000	230000	5000,00	5000,00	
,0500	323000	9900,00	9900,00	
,0200	490000	12280,00	12280,00	
,0100	640000	13350,00	13350,00	
,0050	840000	14150,00	14150,00	
,0020	1000000	14600,00	14600,00	

EXPECTED ANNUAL DAMAGES

BASE COND-COMPUTED	1721,30	1721,30
BASE COND- INPUT	0,00	-0,00
EXIST SYSTEM-INPUT	696,82	696,82

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	,621	,623	233,27	233,27	
2	194036	,134	,279	549,81	549,81	
3	291054	,062	,050	360,93	360,93	
4	388072	,034	,025	265,87	265,87	
5	582108	,013	,014	173,38	173,38	
6	776144	,007	,010	138,03	138,03	

BASE COND DAMAGES	1721,30	1721,30
EXST SYST DAMAGES	696,82	696,82

MODIFIED CONDITIONS FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
,9990	28800	0,00	0,00	
,9000	35000	,00	,00	
,8000	42000	90,00	90,00	
,7000	50500	120,00	120,00	
,6000	60500	140,00	140,00	
,5000	73000	150,00	150,00	
,4000	90000	200,00	200,00	
,3000	114000	250,00	250,00	
,2500	130000	300,00	300,00	
,2000	150000	400,00	400,00	
,1500	180000	700,00	700,00	
,1000	230000	5000,00	5000,00	
,0500	323000	9900,00	9900,00	
,0200	490000	12280,00	12280,00	
,0100	640000	13350,00	13350,00	
,0050	840000	14150,00	14150,00	
,0020	1000000	14600,00	14600,00	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	33134	.621	.623	14.30	14.30	
2	92808	.134	.279	43.91	43.91	
3	150695	.062	.050	19.71	19.71	
4	237896	.034	.025	116.36	116.36	
5	372066	.013	.014	137.08	137.08	
6	612533	.007	.010	132.33	132.33	
	MODIFIED DAMAGES			463.68	463.68	
	DAMAGE REDUCTION			233.14	233.14	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	27735	.621	.623	6.81	6.81	
2	92849	.134	.279	42.36	42.36	
3	138674	.062	.050	15.59	15.59	
4	184898	.034	.025	34.83	34.83	
5	277368	.013	.014	87.18	87.18	
6	369797	.007	.010	108.25	108.25	
	DAMAGES W/ TOTAL CONTROL AT PROJECTS			295.03	295.03	
	REDUCTION POSSIBLE W/ TOTAL CONTROL			401.79	401.79	
	RESIDUAL DAMAGES			168.65	168.65	

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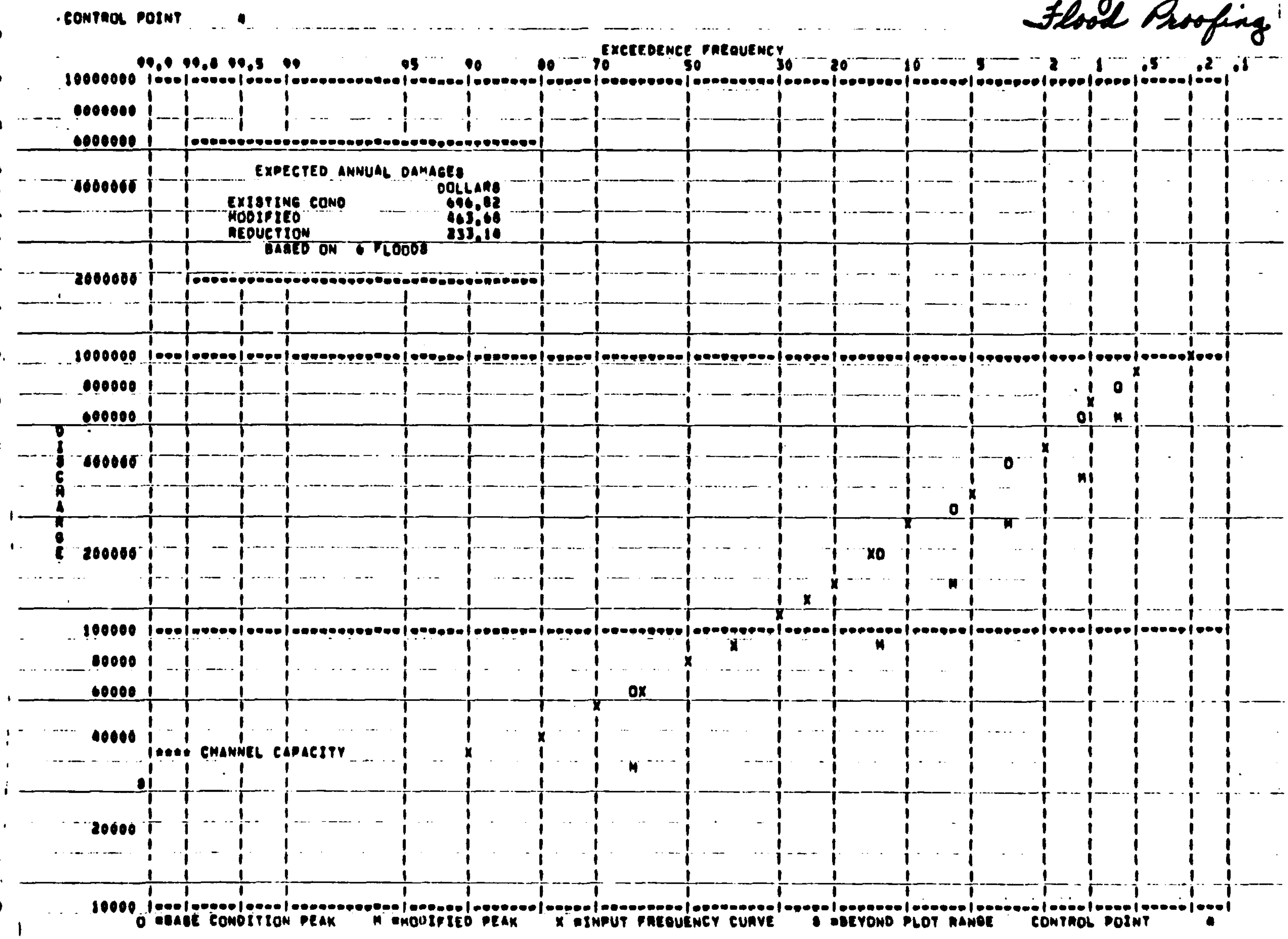

SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES: BASE (EXIST) CONDITION	DAMAGES: MODIFIED CONDITIONS	DAMAGES: UNCONTROL LOCAL COND	DAMAGE REDUCTION: MODIFIED CONDITIONS	DAMAGE REDUCTION: TOTAL CONTROL AT PROJECTS	DAMAGE REDUCTION: RESIDUAL
8	696.02	463.68	295.03	233.14	401.79	168.65
TOTAL	696.02	463.68	295.03	233.14	401.79	168.65

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SYSTEM ECONOMIC COST AND PERFORMANCE SUMMARY
(EXCLUSIVE OF EXISTING SYSTEM COSTS)

TOTAL SYSTEM CAPITAL COST	3000,00	
TOTAL SYSTEM ANNUAL OPERATING MAINTENANCE, AND REPAIR COST	24,36	
TOTAL SYSTEM ANNUAL COST		229,68
AVERAGE ANNUAL DAMAGES - EXISTING SYSTEM	696,82	
AVERAGE ANNUAL DAMAGES - PROPOSED SYSTEM	463,68	
AVERAGE ANNUAL DAMAGE REDUCTION		233,14
AVERAGE ANNUAL SYSTEM NET DAMAGE REDUCTION BENEFITS		3,46

```
HEC-5C-VARIABLE OUTPUT MAR,1975
RES,= 35 CPTS,& 75 PERS,=100

T1 FALL RIVER [illegible]   ***   RELOCATI[illegible]   ***
T2 TRAINING DOC[illegible]T NO. 7
T3 FLOOD RATIOS [illegible]  1.0  1.5  2.0  [illegible]  [illegible]  USED TO COMPUTE ANNUAL DAMAGES
J1      18.00       6.00   [illegible]        2.00        3.00       -0.00       -0.00        1.00       -0.00        1.00
J2      -0.00       1.10   [illegible]        1.00       -0.00        0.00       -1.00       -0.00       -0.00       -1.00
J4       6.00        .30        1.00        1.50        2.00        3.00        4.00       -0.00       -0.00       -0.00

RL       1.00  500[illegible].00   -0.00        0.00    50000.00   150832.00   200000.00       -0.00       -0.00       -0.00
RQ       1.00       4.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RS       6.00  [illegible]    50000.00    70000.00   100000.00   150832.00   200000.00       -0.00       -0.00       -0.00
RQ  [illegible]    5000.00     6000.00     7000.00     8000.00   100000.00   200000.00       -0.00       -0.00       -0.00

CP       1.00    6000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ID RESERV[illegible] A (CP 1)                          -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT       1.30       2.00         .20         .30        6.00       -0.00       -0.00       -0.00       -0.00       -0.00

CP       2.00   21000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ID CP 2                                                -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT       2.00       4.00         .20         .30        6.00       -0.00       -0.00       -0.00       -0.00       -0.00

RL       5.00  100000.00       -0.00        0.00   100000.00   755408.00  1000000.00       -0.00       -0.00       -0.00
RQ       1.00       8.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RS       7.00       0.00   100000.00   200000.00   400000.00   700000.00   800000.00  1000000.00       -0.00       -0.00
RQ       7.00   10000.00    12000.00    18000.00    30000.00    80000.00   150000.00   300000.00       -0.00       -0.00

CP       3.00   12000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ID RESERVOIR C (CP 3)                                  -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT       3.00       4.00         .20         .30        6.00       -0.00       -0.00       -0.00       -0.00       -0.00

CP       4.00   35000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00         .06         .50
ID CP 4                                                -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT       4.00       5.00         .20         .30        6.00       -0.00       -0.00       -0.00       -0.00       -0.00
US       1.00  180000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
CS [illegible]   8450.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
DA       1.00      -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
DB       1.00     696.72       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
DF      17.00       1.00         .90         .80         .70         .60         .50         .40         .30         .25
DF        .20        .15         .10         .05         .02         .01         .01         .00       -0.00       -0.00
DQ      17.00   28800.00    35000.00    42000.00    50500.00    60500.00    73000.00    90000.00   114000.00   130000.00
D[illegible] 150000.00  180000.00   230000.00   323000.00   490000.00   640000.00   840000.00  1000000.00       -0.00       -0.00
Existing
DC       1.00       0.00        0.00      180.00      380.00      500.00      630.00      900.00     1250.00     1500.00
D[illegible] 1930.00    2660.00     5000.00     9900.00    12280.00    13350.00    14150.00    14600.00       -0.00       -0.00
Modified
DC       1.00       0.00        0.00        0.00        0.00        0.00        0.00        0.00        0.00        0.00
D[illegible]  0.00       0.00     2600.00     7500.00     9880.00    10950.00    11750.00    12200.00       -0.00       -0.00

CP       5.00   37000.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ID CP 5                                                -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
RT       5.00       0.00        0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
ED      -0.00      -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00

      NRES=      2  NCPT=      5  NCPTR=     -0

1[illegible]    1  0 JUNE    1000.0   2000.0   3000.0  18000.0  37000.0  42000.0  50000.0  27000.0  20000.0  13000.0
```

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			5000.0	4000.0	3000.0	2000.0	1000.0	1000.0	1000.0	1000.0				
													SUM	231000
IN	2	6 JUNE	2000.0	3000.0	4000.0	6000.0	20000.0	57000.0	100000.0	90000.0	70000.0	50000.0		
			37000.0	24000.0	24000.0	15000.0	9000.0	3000.0	2000.0	1500.0				
													SUM	517500
IN	3	6 JUNE	3000.0	6000.0	27000.0	60000.0	105000.0	78000.0	60000.0	45000.0	33000.0	24000.0		
			18000.0	12000.0	12000.0	9000.0	6000.0	3000.0	2000.0	1000.0				
													SUM	504000
IN	4	6 JUNE	2000.0	4000.0	19000.0	13000.0	10000.0	7000.0	4000.0	1000.0	1000.0	4000.0		
			10000.0	25000.0	13000.0	7000.0	4000.0	2000.0	1000.0	500.0				
													SUM	127500
IN	5	6 JUNE	1000.0	2000.0	9000.0	6000.0	5000.0	3000.0	2000.0	500.0	500.0	2000.0		
			5000.0	12000.0	6000.0	4000.0	2000.0	1000.0	500.0	200.0				
													SUM	61700
EJ	-0		-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0				

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SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASF=LOC	LEVEL	END STOR
1	3850.00	3850.00	[illegible]	[illegible]	.90	2.07	57494.67
3	8400.00	8400.00	[illegible]	[illegible]	1.12	2.03	122385.98

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	Q SPACE	Q BY US	FLOOD BY
2	8625.00	12874.98	12328.87	8671.13	3703.87	876.19
4	10755.92	23035.43	21005.66	13994.37	10249.74	0.00
5	11795.97	24083.97	21119.00	15881.00	9323.08	0.00

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRD= 1 NFLCMN= 6
IFLRD = 1 IFLCMN= 2
FLOWS MULTIPLIED BY 1.00

****

**** LOC 1 RESERVOIR A (CP 1) SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 0,YEAR=19 0.

SERVING 1 4

PER CUM LOCAL Q

PER											
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000	
11	5000	4000	4000	2000	1000	1000	1000	1000			

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER NATURAL FLOW

PER										
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER INFLOW

PER										
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833.333 MAX= 50000.000
MIN= 1000.000

PER OUTFLOW

PER										
1	1000	2000	3000	0	0	0	0	0	0	3658
11	5000	4000	3000	2000	6000	6000	6000	6000		

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AVG= 2687.691 MAX= 6000.000
MIN= 0.000

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PER CASF=LUC,TYP

PER										
1	.03	.03	.03	4.02	4.01	4.00	4.00	4.00	4.00	.04
11	.04	.04	.04	.04	.01	.01	.01	.01		

AVG= 1.353 MAX= 4.020
MIN= .010

PER LEVEL

PER										
1	2.000	2.000	2.000	2.089	2.270	2.477	2.723	2.856	2.958	3.000
11	3.000	3.000	3.000	3.000	2.975	2.951	2.926	2.902		

AVG= 2.673 MAX= 3.000
MIN= 2.000

PER EOP STORAGE

PER										
1	50000	50000	50000	58926	77273	98100	122898	136282	148200	150832
11	150832	150832	150832	150832	148353	145873	143394	140918		

AVG= 117909.368 MAX= 150832.000
MIN= 50000.000

****

**** LOC 2 CP 2 SERVED BY =1

PER CUM LOCAL Q

PER										
1	2000	3000	4000	6000	21000	57300	100000	90000	70000	50000
11	37000	24000	24000	15000	9000	3000	2000	1500		

AVG= 28750.000 MAX= 100000.000
MIN= 1500.000

PER NATURAL FLOW

PER										
1	3000	4167	6028	11338	39056	91513	142180	134857	98809	70302
11	49884	30147	24191	18032	11005	4168	3028	2505		

AVG= 41583.282 MAX= 142180.858
MIN= 2508.058

PER REGULATED FLOW

PER										
1	3000	4167	6028	8338	21390	57065	100011	90002	70000	50610
11	80374	28562	27927	17988	11831	8872	7912	7885		

AVG= 31120.076 MAX= 100010.828
MIN= 3000.000

PER Q SPACE AVAIL.

PER										
1	18000	16833	14972	12662	610	=36065	=79011	=69002	=49000	=29610
11	=19374	=7562	=6927	3012	4169	12528	13088	13515		

AVG= =10120.076 MAX= 18000.000
MIN= =79010.828

PER Q BY US RES,DIVS

PER										
1	1000	1167	2028	2338	300	65	11	2	0	610
11	3374	4562	3927	2988	2831	5872	5912	5985		

AVG= 2370.076 MAX= 5985.330
MIN= .301

PER FLOW BY RES

PER										
1	0		0	0	0	65	11	2	0	610
11	3374		3927	0	0	0	0	0		

AVG= 697.275 MAX= 4562.320

```
                                                                                                         MIN=      0.000
*****************************************************************************************************
**** LOC     3  RESERVOIR C (CP 3)                       SERVED BY      2
                                                                                                 STARTING TIME=       1
                                                                                                 HOUR=12,DAY= 4,MON= 0,YEAR=19 0,
                                      SERVING        2      4
PER         CUM LOCAL Q

   1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
  11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                                 AVG=  28000.000  MAX= 105000.000
                                                                                                                  MIN=   1000.000
PER         NATURAL FLOW

   1    3000    6000   27000   60000  105000   78000   60000   45000   33000   24000
  11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                                 AVG=  28000.000  MAX= 105000.000
                                                                                                                  MIN=   1000.000
PER         INFLOW

   1    3000    6000   27000   50000  105000   78000   60000   45000   33000   24000
  11   18000   12000   12000    9000    6000    3000    2000    1000

                                                                                                 AVG=  28000.000  MAX= 105000.000
                                                                                                                  MIN=   1000.000
PER         OUTFLOW

   1    3000    6000   12000       0       0       0       0       0       0       0
  11       0       0       0       0   12000   12000   12000   12000

                                                                                                 AVG=   3833.333  MAX=  12000.000
                                                                                                                  MIN=      0.000
PER         CASE=LOC.TYP

   1     .03     .03     .01    4.02    4.01    4.00    4.00    4.00    4.00    4.00
  11    4.00    4.00    4.00    4.00     .01     .01     .01     .01

                                                                                                 AVG=      2.452  MAX=      4.020
                                                                                                                  MIN=       .010
PER         LEVEL

   1   2.000   2.000   2.011   2.057   2.136   2.195   2.241   2.275   2.300   2.318
  11   2.331   2.340   2.350   2.356   2.352   2.345   2.337   2.329

                                                                                                 AVG=      2.237  MAX=      2.356
                                                                                                                  MIN=      2.000
PER         EOP STORAGE

   1  100000  100000  107438  137191  189257  227936  257688  280003  296366  308267
  11  317193  323144  329094  333557  330542  326119  321160  315706

                                                                                                 AVG= 255594.556  MAX= 333557.125
                                                                                                                  MIN= 100000.000
*****************************************************************************************************
**** LOC     4  CP 4                                     SERVED BY      1      2

PER         CUM LOCAL Q

   1    4000    6167   22028   17171   18029   31171   62695   92449   87908   73485
  11   61081   62180   39197   29866   19311   11052    4842    2724
```

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AVG= 35853,070 MAX= 92489,200
MIN= 2723,062

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PER NATURAL FLOW

PER										
1	8000	10694	32398	49141	87592	144277	173798	194036	175045	136597
11	106281	93327	59185	45907	31355	19091	9465	5847		

AVG= 76784,776 MAX= 194036,091
MIN= 5846,858

PER REGULATED FLOW

PER										
1	8000	10694	29898	21225	21494	32020	62882	92488	87916	73588
11	62067	65354	43422	33666	24411	24701	21750	20881		

AVG= 41282,055 MAX= 92487,801
MIN= 8000,000

PER Q SPACE AVAIL.

PER										
1	27000	24306	5102	6775	13576	2980	-27882	-57488	-52918	-38588
11	-27067	-30354	-8422	1314	10549	10299	13250	14519		

AVG= -6282,055 MAX= 27000,000
MIN= -57487,801

PER Q BY US RES,DIVS

PER										
1	4000	4528	7470	11053	5466	848	186	39	8	103
11	986	3174	4225	3820	5100	13650	16908	17757		

AVG= 5428,984 MAX= 17756,907
MIN= 7,685

PER FLOOD BY RES

PER										
1	0	0	0	0	0	0	186	39	8	103
11	986	3174	4225	0	0	0	0	0		

AVG= 848,498 MAX= 4225,056
MIN= 0,000

****

**** LOC 5 [illegible] SERVED BY -1 -2

PER [illegible] Q

PER										
1	50[illegible]	[illegible]	17509	24965	22613	23150	36588	63470	87279	87316
11	783[illegible]	[illegible]	64539	44865	31940	20706	11959	5792		

AVG= 39319,488 MAX= 87316,106
MIN= 5000,000

PER NATURAL FLOW

PER										
1	9000	10489	22937	38112	57711	94226	142355	172097	187631	172652
11	142220	121279	96295	66172	48252	32794	20104	10752		

AVG= 80279,888 MAX= 187631,160
MIN= 9000,000

PER REGULATED FLOW

PER										
1	9000	10489	22521	32890	31840	27146	37851	63811	87363	87352
11	76628	76542	67563	48823	35997	27057	24936	22186		

AVG= 43999,739 MAX= 87363,008
MIN= 9000,000

PER Q SPACE AVAIL.

PER										
1	28000	26551	14479	4110	5128	9854	-851	-26811	-50363	-50352
11	-41628	-39542	-30563	-11823	1043	9943	12064	14814		

AVG= -6999,739 MAX= 28000,000
MIN= -50363,008

PER Q BY US RES,DIVS

1	4000	4088	5012	7924	9267	3996	1263	341	84	36
11	239	1226	3025	3957	4056	6351	12976	16394		

AVG= 4679,852 MAX= 16394,328
MIN= 36,288

PER FLOOD BY RES

1	0	0	0	0	0	0	851	341	84	36
11	239	1226	3025	3957	0	0	0	0		

AVG= 542,212 MAX= 3957,493
MIN= 0,000

****

CUM TIME= 1

RES NO=	1	3
INFLOW	1000	3000
OUTFLOW	1000	3000
EOP STOR	50000	100000
CASE=	,03	,03
LEVEL	2,000	2,000
EQ LEVEL	2,000	2,000

CUM TIME= 2

RES NO=	1	3
INFLOW	2000	6000
OUTFLOW	2000	6000
EOP STOR	50000	100000
CASE=	,03	,03
LEVEL	2,000	2,000
EQ LEVEL	2,000	2,000

CUM TIME= 3

RES NO=	1	3
INFLOW	3000	27000
OUTFLOW	3000	12000
EOP STOR	50000	107438
CASE=	,03	,01
LEVEL	2,000	2,011
EQ LEVEL	2,000	2,011

CUM TIME= 4

RES NO=	1	3
INFLOW	18000	60000
OUTFLOW	0	0
EOP STOR	58926	137191
CASE=	4,02	4,02
LEVEL	2,089	2,057
EQ LEVEL	2,089	2,057

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FALL RIVER BASIN *** RELOCATION ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES
FLOOD SUMMARY-EACH FLOOD COPY* 1

***** FLOOD NUMBER 1 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	1,007	34777 *	1,007	42642 *	1,007	30000 *	4777 *	0,00	0,00
LOC 4 CP 4	1,012	33134 *	1,008	58211 *	1,008	27735 *	5400 *	0,00	0,00
LOC 5 CP 5	1,012	33586 *	1,009	56289 *	1,010	26195 *	7391 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	1,018	50000	2,000 *	1,008	67393	2,173 *	1,005	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	1,013	100000	2,000 *	1,010	140755	2,062 *	1,004	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 208148

***** FLOOD NUMBER 2 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	2,007	100011 *	2,007	142140 *	2,007	100000 *	11 *	0,00	0,00
LOC 4 CP 4	2,008	92488 *	2,008	198036 *	2,008	92449 *	39 *	0,00	0,00
LOC 5 CP 5	2,009	87363 *	2,009	187631 *	2,010	87316 *	47 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	2,013	50000	2,000 *	2,011	150832	3,000 *	2,015	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	2,012	100000	2,000 *	2,014	333557	2,356 *	2,003	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 484389

***** FLOOD NUMBER 3 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	3,007	157221 *	3,007	213211 *	3,007	150000 *	7221 *	0,00	0,00
LOC 4 CP 4	3,009	150695 *	3,008	291054 *	3,008	138674 *	12022 *	0,00	0,00
LOC 5 CP 5	3,010	150348 *	3,009	281447 *	3,010	130974 *	19374 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	3,001	50744	2,007 *	3,007	150832	3,000 *	3,008	60499	6000	50000

		FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	3 RESERVOIR C (CP 3)	3.001	102231	2.003 *	3.015	470418	2.565 *	3.016	12000	12000	100000

MIN SYSTEM STG= 152974 MAX SYSTEM STG= 621250

***** FLOOD NUMBER 4 *****

STARTING TIME 1

		FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC	2 CP 2	4.008	252767 *	4.007	284281 *	4.007	200000 *	52767 *	0.00	0.00
LOC	4 CP 4	4.009	237896 *	4.008	388072 *	4.008	184898 *	52998 *	0.00	0.00
LOC	5 CP 5	4.010	229892 *	4.009	375262 *	4.010	174632 *	[illegible] *	0.00	0.00

	RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	4.001	50992	2.010 *	4.007	150832	3.000 *	4.007	[illegible]	6000	50000
LOC	3 RESERVOIR C (CP 3)	4.001	102975	2.005 *	4.015	593891	2.754 *	4.016	12000	12000	100000

MIN SYSTEM STG= 153966 MAX SYSTEM STG= 744723

***** FLOOD NUMBER 5 *****

STARTING TIME 1

		FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC	2 CP 2	5.008	383382 *	5.007	426421 *	5.007	300000 *	83382 *	0.00	0.00
LOC	4 CP 4	5.009	372066 *	5.008	582108 *	5.008	277348 *	94718 *	0.00	0.00
LOC	5 CP 5	5.010	365070 *	5.009	562893 *	5.010	261948 *	103121 *	0.00	0.00

	RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	5.001	51488	2.015 *	5.007	168236	3.354 *	5.007	120542	6000	50000
LOC	3 RESERVOIR C (CP 3)	5.001	104463	2.007 *	5.011	755403	3.000 *	5.012	35999	12000	100000

MIN SYSTEM STG= 155949 MAX SYSTEM STG= 923644

***** FLOOD NUMBER 6 *****

STARTING TIME 1

		FLD.PER	MAX REG Q *	FLD.PER	MAX NAT Q *	FLD.PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC	2 CP 2	6.007	516031 *	6.007	568562 *	6.007	400000 *	116031 *	0.00	0.00
LOC	4 CP 4	6.009	612533 *	6.008	776144 *	6.008	369797 *	242734 *	0.00	0.00
LOC	5 CP 5	6.010	594538 *	6.009	750525 *	6.010	349264 *	245274 *	0.00	0.00

	RESERVOIRS	FLD.PER	MIN STG	MIN LEVEL *	FLD.PER	MAX STG	MAX LEVEL *	FLD.PER	MAX REL	CHAN CAP	STOR1
LOC	1 RESERVOIR A (CP 1)	6.001	51983	2.020 *	6.007	191183	3.821 *	6.007	163829	6000	50000
LOC	3 RESERVOIR C (CP 3)	6.001	105950	2.009 *	6.008	781273	3.106 *	6.009	136168	12000	100000

MIN SYSTEM STG= 157933 MAX SYSTEM STG= 972456

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2660.00	2660.00	
.1000	230000	5000.00	5000.00	
.0500	323000	9900.00	9900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES

	SUM	TYPE 1
BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00
EXIST SYSTEM-INPUT	696.82	696.82

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.621	.623	233.27	233.27	
2	194036	.134	.279	549.81	549.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.034	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776144	.007	.010	138.03	138.03	

	SUM	TYPE 1
BASE COND DAMAGES	1721.30	1721.30
EXST SYST DAMAGES	696.82	696.82

MODIFIED CONDITIONS FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	0.00	0.00	
.7000	50500	0.00	0.00	
.6000	60500	0.00	0.00	
.5000	73000	0.00	0.00	
.4000	90000	0.00	0.00	
.3000	114000	0.00	0.00	
.2500	130000	0.00	0.00	
.2000	150000	0.00	0.00	
.1500	180000	.00	.00	
.1000	230000	2600.00	2600.00	
.0500	323000	7500.00	7500.00	
.0200	490000	9880.00	9880.00	
.0100	640000	10950.00	10950.00	
.0050	840000	11750.00	11750.00	
.0020	1000000	12200.00	12200.00	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	331[illegible]	.621	.[illegible]3	0.00	0.0[illegible]	
2	92[illegible]	.134	.279	0.00	0.0[illegible]	
3	150[illegible]	.062	.050	.22	.22	
4	237[illegible]6	.034	.025	66.84	66.8[illegible]	
5	372[illegible]	.013	.014	104.05	104.05	
6	612533	.007	.010	108.95	108.95	
	MODIFIED DAMAGES			280.07	280.07	
	DAMAGE REDUCTION			416.75	416.75	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	27735	.621	.623	0.00	0.00	
2	92849	.134	.279	0.00	0.0[illegible]	
3	138674	.062	.050	0.00	0.00	
4	184898	.034	.025	11.52	11.52	
5	277348	.013	.014	54.75	54.75	
6	369797	.007	.010	84.87	84.87	
	DAMAGES W/ TOTAL CONTROL AT PROJECTS			151.14	151.14	
	REDUCTION POSSIBLE W/ TOTAL CONTROL			545.68	545.68	
	RESIDUAL DAMAGES			128.92	128.92	

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AD-A106 700 HYDROLOGIC ENGINEERING CENTER DAVIS CA F/G 13/2
ANALYSIS OF STRUCTURAL AND NONSTRUCTURAL FLOOD CONTROL MEASURES--ETC(U)
NOV 75 W K JOHNSON, D W DAVIS

UNCLASSIFIED HEC-TD-7 NL

3 of 3
AD A106700

END
DATE
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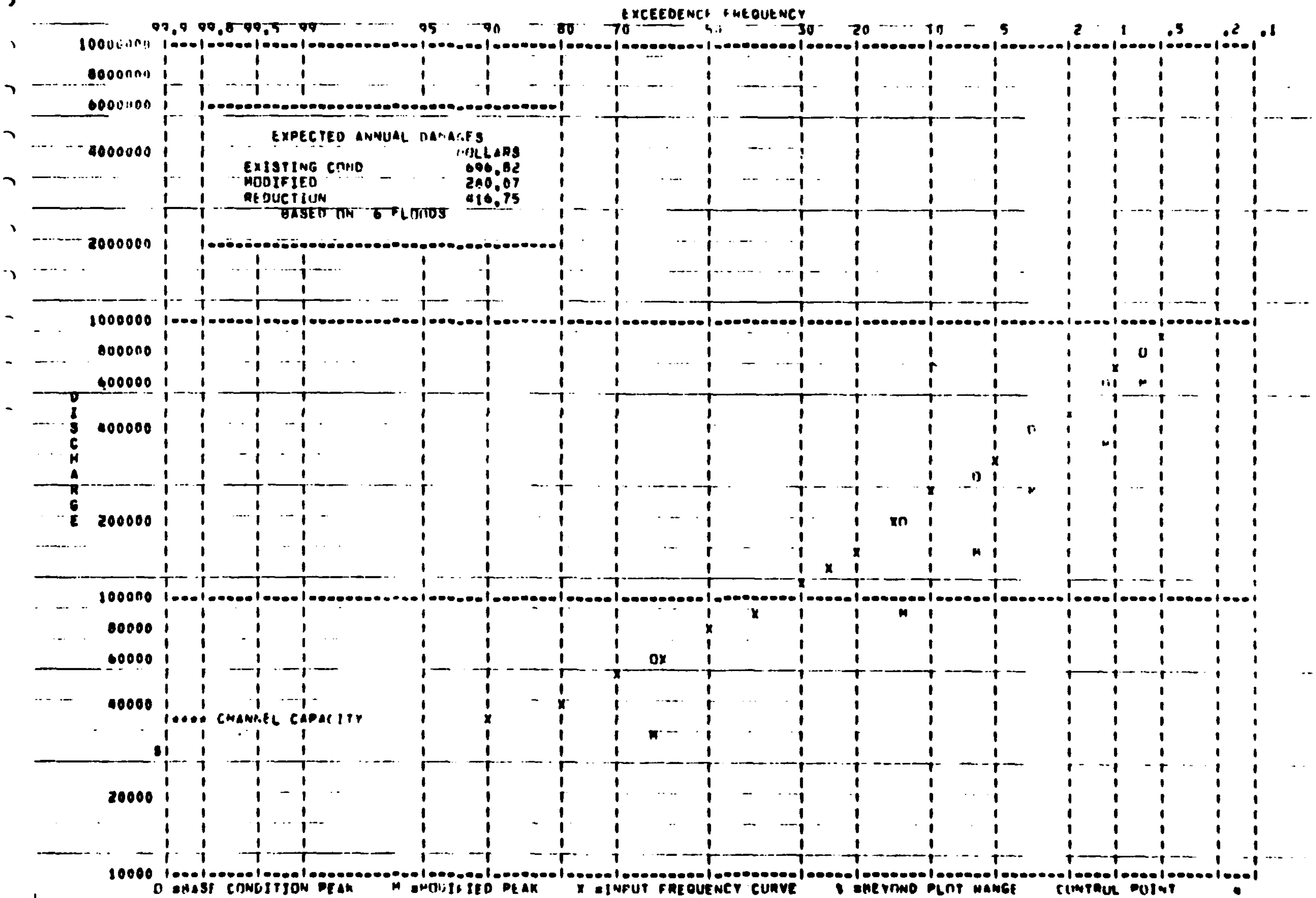
CONTROL POINT 4



SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES: BASE (EXIST) CONDITION	DAMAGES: MODIFIED CONDITIONS	DAMAGES: UNCONTROL LOCAL COND	DAMAGE REDUCTION: MODIFIED CONDITIONS	DAMAGE REDUCTION: TOTAL CONTROL AT PROJECTS	DAMAGE REDUCTION: RESIDUAL
8	696,82	280,07	151,14	416,75	545,68	128,92
TOTAL	696,82	280,07	151,14	416,75	545,68	128,92

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SYSTEM ECONOMIC COST AND PERFORMANCE SUMMARY
(EXCLUSIVE OF EXISTING SYSTEM COSTS)

TOTAL SYSTEM CAPITAL COST	8450.00	
TOTAL SYSTEM ANNUAL OPERATING MAINTENANCE, AND REPAIR COST	22.25	
TOTAL SYSTEM ANNUAL COST		284.80
AVERAGE ANNUAL DAMAGES - EXISTING SYSTEM	696.82	
AVERAGE ANNUAL DAMAGES - PROPOSED SYSTEM	280.07	
AVERAGE ANNUAL DAMAGE REDUCTION		416.75
AVERAGE ANNUAL SYSTEM NET DAMAGE REDUCTION BENEFITS		131.95

```
HEC-5C-VARIABLE OUTPUT MAR,1975
RES,= 35 CPTS,= 75 PERS,=100

T1 FALL RIVER BASIN  *** FLOOD WARNING ***
T2 TRAINING DOCUMENT NO. 7
T3 FLOOD RATIOS .3  1.0  1.5  2.0  3.0  4.0  USED TO COMPUTE ANNUAL DAMAGES
J1      10.00       6.00       4.00       2.00       3.00      -0.00      -0.00       1.00      -0.00       1.00
J2      -0.00       1.10       2.00       1.00      -0.00       0.00      -1.00      -0.00      -0.00      -1.00
J4       6.00        .30       1.00       1.50       2.00       3.00       4.00      -0.00      -0.00      -0.00

RL       1.00   50000.00      -0.00       0.00   50000.00  150832.00  200000.00      -0.00      -0.00      -0.00
RO       1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RS       6.00       0.00   50000.00   70000.00  100000.00  150832.00  200000.00      -0.00      -0.00      -0.00
RQ       6.00    5000.00    6000.00    7000.00    8000.00  100000.00  200000.00      -0.00      -0.00      -0.00

CP       1.00    6000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID RESERVOIR A (CP 1)                             -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       1.00       2.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

CP       2.00   21000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 2                                           -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       2.00       4.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

RL       3.00  100000.00      -0.00       0.00  100000.00  755408.00 1000000.00      -0.00      -0.00      -0.00
RO       1.00       4.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RS       7.00       0.00  100000.00  200000.00  400000.00  700000.00  800000.00 1000000.00      -0.00      -0.00
RQ       7.00   10000.00   12000.00   18000.00   30000.00  600000.00  150000.00  500000.00      -0.00      -0.00

CP       3.00   12000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID RESERVOIR C (CP 3)                             -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       3.00       4.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00

CP       4.00   35000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      (.06)       5.00
ID CP 4                                           -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       4.00       5.00        .20        .30       6.00      -0.00      -0.00      -0.00      -0.00      -0.00
QS       1.00   35000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
CS   35000.00     100.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DA       1.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DB       1.00     690.82      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
DF      17.00       1.00        .90        .80        .70        .60        .50        .40        .30        .25
DF        .20        .15        .10        .05        .02        .01        .01        .00      -0.00      -0.00
DQ      17.00   28800.00   35000.00   42000.00   50500.00   60500.00   73000.00   90000.00  114000.00  130000.00
DQ  150000.00  180000.00  230000.00  323000.00  490000.00  640000.00  840000.00 1000000.00      -0.00      -0.00
EXISTING DC       1.00       0.00       0.00     180.00     380.00     500.00     630.00     900.00    1250.00    1500.00
DC    1930.00    2660.00    5000.00    9900.00   12200.00   13350.00   14150.00   14600.00      -0.00      -0.00
MODIFIED DC       1.00       0.00       0.00     171.00     361.00     475.00     598.00     855.00    1187.00    1425.00
DC    1833.00    2527.00    4750.00    9405.00   11609.00   12682.00   13442.00   13870.00      -0.00      -0.00

CP       5.00   37000.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ID CP 5                                           -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
RT       5.00       0.00       0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00
ED      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00      -0.00

   NRESR    2  NCPTR    5  NCPTRR   =0

IN     1  6 JUNE    1000.0   2000.0   3000.0  16000.0  37000.0  42000.0  50000.0  27000.0  20000.0  13000.0
                    5000.0   4000.0   3000.0   2000.0   1000.0   1000.0   1000.0   1000.0
                                                                                              SUM=   231000
IN     2  6 JUNE    2000.0   3000.0   4000.0   6000.0  20000.0  57000.0 100000.0  90000.0  70000.0  50000.0
```

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		37000.0	24000.0	24000.0	15000.0	9000.0	3000.0	2000.0	1500.0				
IN	3 6 JUNE	3000.0	6000.0	27000.0	60000.0	105000.0	78000.0	60000.0	45000.0	33000.0	24000.0	SUM=	517500
		10000.0	12000.0	12000.0	9000.0	6000.0	3000.0	2000.0	1000.0				
IN	4 6 JUNE	2000.0	4000.0	19000.0	13000.0	10000.0	7000.0	4000.0	1000.0	1000.0	4000.0	SUM=	504000
		10000.0	25000.0	13000.0	7000.0	4000.0	2000.0	1000.0	500.0				
IN	5 6 JUNE	1000.0	2000.0	9000.0	6000.0	5000.0	3000.0	2000.0	500.0	500.0	2000.0	SUM=	127500
		5000.0	12000.0	6000.0	4000.0	2000.0	1000.0	500.0	200.0				
EJ	-0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0			SUM=	61700

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SUMMARY OF AVERAGES FOR RESERVOIRS

LOC=	CUM LOCA	NATURAL	INFLOW	OUTFLOW	CASE=LOC	LEVEL	EOP STOR
1	3850,00	3850,00	3850,00	3850,00	,90	2,07	57494,67
3	8400,00	8880,00	8480,00	7460,42	1,12	2,83	122385,98

SUMMARY OF AVERAGES FOR NON RESERVOIRS

LOC=	CUM LOCA	NATURAL	REGULATE	Q SPACE	Q BY US	FLOOD BY
2	8625,00	12474,90	12328,47	8671,13	3703,87	476,19
4	10755,92	23035,43	21005,46	13994,34	10249,74	0,00
5	11795,97	24083,97	21117,00	15881,00	9323,04	0,00

COMPUTATION INTERVAL IN HOURS= 6

***** FLOOD NUMBER 2 *****

NFLRDS= 1 NFLCON= 6
IFLRD = 1 IFLCON= 2
FLOWS MULTIPLIED BY 1,00

****

**** LOC 1 RESERVOIR A (CP 1) SERVED BY 1

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 0,YEAR=19 0,

SERVING 1 4

PER	CUM LOCAL Q									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833,333 MAX= 50000,000
MIN= 1000,000

PER	NATURAL FLOW									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833,333 MAX= 50000,000
MIN= 1000,000

PER	INFLOW									
1	1000	2000	3000	18000	37000	42000	50000	27000	20000	13000
11	5000	4000	3000	2000	1000	1000	1000	1000		

AVG= 12833,333 MAX= 50000,000
MIN= 1000,000

PER	OUTFLOW									
1	1000	2000	3000	0	0	0	0	0	0	3650
11	5000	4000	3000	2000	6000	6000	6000	6000		

AVG= 2667,091 MAX= 6000,000
MIN= 0,000

PER	CASE=LOC,TYP									
1	,03	,03	,03	4,02	4,01	4,00	4,00	4,00	4,00	,04

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```
 11     .04     .04     .04     .04     .01     .01     .01     .01
                                                                                   AVG=     1.353  MAX=     4.020
                                                                                                  MIN=      .010

PER        LEVEL

  1   2.000   2.000   2.000   2.049   2.270   2.477   2.723   2.856   2.954   3.000
 11   3.000   3.000   3.000   3.000   2.975   2.951   2.926   2.902
                                                                                   AVG=     2.673  MAX=     3.000
                                                                                                  MIN=     2.000

PER        EOP STORAGE

  1   50000   50000   50000   58926   77273   98100  122894  136282  146200  150032
 11  150832  150832  150832  150832  148363  145873  143394  140914
                                                                                   AVG= 117909.368 MAX= 150832.000
                                                                                                  MIN=  50000.000
*****************************************************************************************************************

**** LOC     2  CP 2                               SERVED BY     1

PER        CUM LOCAL Q

  1    2000    3000    4000    5000   20000   57000  100000   90000   70000   50000
 11   37000   24000   24000   15000    9000    3000    2000    1500
                                                                                   AVG=  28750.000 MAX= 100000.000
                                                                                                  MIN=   1500.000

PER.       NATURAL FLOW

  1    3000    4167    6028   11338   39096   91843  142140  130857   98809   70302
 11   89888   30147   20191   18032   11005    4168    3028    2505
                                                                                   AVG=  41583.282 MAX= 142140.454
                                                                                                  MIN=   2504.654

PER        REGULATED FLOW

  1    3000    4167    6028    8338   20390   57005  100011   90002   70000   50610
 11   40374   20562   27927   17988   11831    8172    7912    7485
                                                                                   AVG=  31120.076 MAX= 100010.824
                                                                                                  MIN=   3000.000

PER        Q SPACE AVAIL.

  1   18000   16033   14972   12662     610  -36065  -79011  -69002  -49000  -29610
 11  -19378   -7562   -6927    3012    9169   12528   13088   13515
                                                                                   AVG= -10120.076 MAX=  18000.000
                                                                                                  MIN= -79010.824

PER        Q BY US RES,DIVS

  1    1000    1167    2028    2338     340      65      11       2       0     610
 11    3374    4562    3927    2988    2831    5472    5912    5985
                                                                                   AVG=   2370.076 MAX=   5985.330
                                                                                                  MIN=       .301

PER        FLOOD BY RES

  1       0       0       0       0       0      65      11       2       0     610
 11    3374    4562    3927       0       0       0       0       0
                                                                                   AVG=    697.275 MAX=   4562.320
                                                                                                  MIN=       0.000
*****************************************************************************************************************
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**** LOC 3 RESERVOIR C (CP 3) SERVED BY 2

STARTING TIME= 1
HOUR=12,DAY= 4,MON= 0,YEAR=19 0,

SERVING 2 4

PER CUM LOCAL Q

PER										
1	3000	6000	27000	60000	105000	78000	60000	45000	33000	24000
11	18000	12000	12000	9000	6000	3000	2000	1000		

AVG= 28000.000 MAX= 105000.000
MIN= 1000.000

PER NATURAL FLOW

PER										
1	3000	6000	27000	60000	105000	78000	60000	45000	33000	24000
11	18000	12000	12000	9000	6000	3000	2000	1000		

AVG= 28000.000 MAX= 105000.000
MIN= 1000.000

PER INFLOW

PER										
1	3000	6000	27000	60000	105000	78000	60000	45000	33000	24000
11	18000	12000	12000	9000	6000	3000	2000	1000		

AVG= 28000.000 MAX= 105000.000
MIN= 1000.000

PER OUTFLOW

PER										
1	3000	6000	12000	0	0	0	0	0	0	0
11	0	0	0	0	12000	12000	12000	12000		

AVG= 3033.333 MAX= 12000.000
MIN= 0.000

PER CASE=LOC,TYP

PER										
1	.03	.03	.01	4.02	4.01	4.00	4.00	4.00	4.00	4.00
11	4.00	4.00	4.00	4.00	.01	.01	.01	.01		

AVG= 2.452 MAX= 4.020
MIN= .010

PER LEVEL

PER										
1	2.000	2.000	2.011	2.057	2.136	2.195	2.281	2.275	2.300	2.318
11	2.331	2.340	2.350	2.356	2.352	2.345	2.337	2.329		

AVG= 2.237 MAX= 2.356
MIN= 2.000

PER EOP STORAGE

PER										
1	100000	100000	107438	137191	184257	227936	257688	280003	296366	308267
11	317193	323144	329094	333557	330582	326119	321160	315706		

AVG= 255594.556 MAX= 333557.125
MIN= 100000.000

****

**** LOC 4 CP 4 SERVED BY 1 2

PER CUM LOCAL Q

PER										
1	4000	6167	22024	17171	18029	31171	62695	92449	87906	73685
11	61081	62180	391[illegible]	29866	19311	11052	4042	2724		

AVG= 35853.070 MAX= 92449.206
MIN= 2723.662

PER NATURAL FLOW

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```
  1    8000   10494   32398   49161   87592  144277  173798  194036  175045  136597
 11  106281   93327   59185   45907   31365   19091    9465    5847
                                                                                  AVG=  76784.776  MAX= 194036.091
                                                                                                   MIN=   5846.858
PER        REGULATED FLOW

  1    8000   10494   29898   28225   21444   32020   62882   92488   87916   73588
 11   62067   65354   43422   33686   24411   24701   21750   20481
                                                                                  AVG=  41282.055  MAX=  92487.801
                                                                                                   MIN=   8000.000
PER        G SPACE AVAIL.

  1   27000   24306    5102    6775   13506    2980  -27882  -57488  -52916  -36588
 11  -27067  -30354   -8822    1314   10589   10299   13250   14519
                                                                                  AVG= -6282.055   MAX=  27000.000
                                                                                                   MIN= -57487.801
PER        G BY US RES,DIVS

  1    4600    4528    7870   11053    3466     848     186      39       8     103
 11     986    3174    4225    3820    5100   13650   16908   17757
                                                                                  AVG=   5428.984  MAX=  17756.907
                                                                                                   MIN=      7.645
PER        FLOOD BY RES

  1       0       0       0       0       0       0     186      39       8     103
 11     986    3174    4225       0       0       0       0       0
                                                                                  AVG=    484.498  MAX=   4225.[illegible]
                                                                                                   MIN=      [illegible]
*****************************************************************************************************

**** LOC     5  CP 5                         SERVED BY    -1    -2
PER        CUM LOCAL Q

  1    5000    6361   17509   24965   22613   23150   36588   63478   87279   87316
 11   78389   75315   64539   48865   31940   20706   11959    5792
                                                                                  AVG=  39319.888  MAX=  87316.106
                                                                                                   MIN=   5000.000
PER        NATURAL FLOW

  1    9000   10449   22937   38112   57711   94226  142355  172097  187631  172652
 11  142220  121274   96295   66172   49252   32798   20104   10752
                                                                                  AVG=  80279.898  MAX= 187631.160
                                                                                                   MIN=   9000.000
PER        REGULATED FLOW

  1    9000   10449   22521   33990   31840   27144   37851   63811   87363   87352
 11   78628   76542   67563   48823   35997   27057   24936   22186
                                                                                  AVG=  43999.739  MAX=  87363.008
                                                                                                   MIN=   9000.000
PER        G SPACE AVAIL.

  1   28000   26551   14479    4110    5120    9854    -851  -26811  -50363  -50352
 11  -41628  -39542  -30563  -11823    1003    9943   12064   14814
                                                                                  AVG= -6999.739   MAX=  28000.000
                                                                                                   MIN= -50363.008
```

```
PER        Q BY US RES,DIVS

   1    4000    4088    5012    7924    9267    3996    1263     341      88      36
  11     239    1226    3025    3957    4056    6351   12976   16394

                                                              AVG=   4679,892  MAX=  16394,328
PER        FLOOD BY RES                                                         MIN=     36,288

   1       0       0       0       0       0       0     851     341      84      36
  11     239    1226    3025    3957       0       0       0       0

                                                              AVG=    542,212  MAX=   3957,493
                                                                                MIN=      0,000
*******************************************************************************************

               CUM TIME=     1

RES NO=          1        3
INFLOW        1000     3000
OUTFLOW       1000     3000
EOP STOR     50000   100000
CASE=          ,03      ,03
LEVEL        2,000    2,000
EQ LEVEL     2,000    2,000

               CUM TIME=     2

RES NO=          1        3
INFLOW        2000     6000
OUTFLOW       2000     6000
EOP STOR     50000   100000
CASE=          ,03      ,03
LEVEL        2,000    2,000
EQ LEVEL     2,000    2,000

               CUM TIME=     3

RES NO=          1        3
INFLOW        3000    27000
OUTFLOW       3000    12000
EOP STOR     50000   107438
CASE=          ,03      ,01
LEVEL        2,000    2,011
EQ LEVEL     2,000    2,011

               CUM TIME=     4

RES NO=          1        3
INFLOW       18000    60000
OUTFLOW          0        0
EOP STOR     58926   137191
CASE=         4,02     4,02
LEVEL        2,089    2,057
EQ LEVEL     2,089    2,057

               CUM TIME=     5
```

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FALL RIVER BASIN *** FLOOD WARNING ***
TRAINING DOCUMENT NO. 7
FLOOD RATIOS .3 1.0 1.5 2.0 3.0 4.0 USED TO COMPUTE ANNUAL DAMAGES

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FLOOD SUMMARY-EACH FLOOD CONTR 1

***** FLOOD NUMBER 1 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	1,007	34777 *	1,007	42642 *	1,007	30000 *	4777 *	0,00	0,00
LOC 4 CP 4	1,012	33138 *	1,008	58211 *	1,008	27735 *	5400 *	0,00	0,00
LOC 5 CP 5	1,012	33586 *	1,009	56289 *	1,010	26195 *	7391 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	1,018	50000	2,000 *	1,008	67393	2,173 *	1,005	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	1,003	100000	2,000 *	1,010	140755	2,062 *	1,008	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 208148

***** FLOOD NUMBER 2 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	2,007	100211 *	2,007	142140 *	2,007	100000 *	11 *	0,00	0,00
LOC 4 CP 4	2,008	92058 *	2,008	194036 *	2,008	92449 *	39 *	0,00	0,00
LOC 5 CP 5	2,009	87363 *	2,009	187631 *	2,010	87316 *	47 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	2,003	50000	2,000 *	2,011	150832	3,000 *	2,015	6000	6000	50000
LOC 3 RESERVOIR C (CP 3)	2,002	100000	2,000 *	2,014	333557	2,356 *	2,003	12000	12000	100000

MIN SYSTEM STG= 150000 MAX SYSTEM STG= 484389

***** FLOOD NUMBER 3 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE DES	INDEX REQ
LOC 2 CP 2	3,007	157221 *	3,007	213211 *	3,007	150000 *	7221 *	0,00	0,00
LOC 4 CP 4	3,009	150695 *	3,008	291054 *	3,008	138674 *	12022 *	0,00	0,00
LOC 5 CP 5	3,010	150348 *	3,009	281447 *	3,010	130974 *	19374 *	0,00	0,00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	3,001	50744	2,007 *	3,007	150832	3,000 *	3,008	40499	6000	50000
LOC 3 RESERVOIR C (CP 3)	3,001	102231	2,003 *	3,015	470418	2,565 *	3,016	12000	12000	100000

MIN SYSTEM STG= 152974 MAX SYSTEM STG= 621250

***** FLOOD NUMBER 4 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC 2 CP 2	4,008	252767 *	4,007	288281 *	4,007	200000 *	52767 *	0.00	0.00
LOC 4 CP 4	4,009	237896 *	4,008	380072 *	4,008	184898 *	52990 *	0.00	0.00
LOC 5 CP 5	4,010	229892 *	4,009	375262 *	4,010	174632 *	55259 *	0.00	0.00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	4,001	50992	2,010 *	4,007	150832	3,000 *	4,007	90658	6000	50000
LOC 3 RESERVOIR C (CP 3)	4,001	102975	2,005 *	4,015	593891	2,754 *	4,010	12000	12000	100000

MIN SYSTEM STG= 153966 MAX SYSTEM STG= 784723

***** FLOOD NUMBER 5 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC 2 CP 2	5,008	[illegible]3382 *	5,007	426421 *	5,007	300000 *	83382 *	0.00	0.00
LOC 4 CP 4	5,009	372066 *	5,008	582108 *	5,008	277348 *	94718 *	0.00	0.00
LOC 5 CP 5	5,010	3[illegible]5070 *	5,009	562893 *	5,010	261948 *	103121 *	0.00	0.00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	5,001	51486	2,015 *	5,007	168236	3,358 *	5,007	120542	6000	50000
LOC 3 RESERVOIR C (CP 3)	5,001	104463	2,007 *	5,011	755408	3,000 *	5,012	35999	12000	100000

MIN SYSTEM STG= 155949 MAX SYSTEM STG= 923644

***** FLOOD NUMBER 6 *****

STARTING TIME 1

	FLD,PER	MAX REG Q *	FLD,PER	MAX NAT Q *	FLD,PER	MAX LOC Q *	Q BY RES *	SHORTAGE INDEX DES	SHORTAGE INDEX REQ
LOC 2 CP 2	6,007	516031 *	6,007	568562 *	6,007	400000 *	116031 *	0.00	0.00
LOC 4 CP 4	6,009	612533 *	6,008	776144 *	6,008	369797 *	242736 *	0.00	0.00
LOC 5 CP 5	6,010	594538 *	6,009	750525 *	6,010	349264 *	245274 *	0.00	0.00

RESERVOIRS	FLD,PER	MIN STG	MIN LEVEL *	FLD,PER	MAX STG	MAX LEVEL *	FLD,PER	MAX REL	CHAN CAP	STOR1
LOC 1 RESERVOIR A (CP 1)	6,001	51983	2,020 *	6,007	191183	3,821 *	6,007	163829	6000	50000
LOC 3 RESERVOIR C (CP 3)	6,001	105950	2,009 *	6,008	781273	3,106 *	6,009	136168	12000	100000

MIN SYSTEM STG= 157933 MAX SYSTEM STG= 972456

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EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
CONTROL POINT NUMBER 4

BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28600	0.00	0.00	
.9000	35000	0.00	0.00	
.8000	42000	180.00	180.00	
.7000	50500	380.00	380.00	
.6000	60500	500.00	500.00	
.5000	73000	630.00	630.00	
.4000	90000	900.00	900.00	
.3000	114000	1250.00	1250.00	
.2500	130000	1500.00	1500.00	
.2000	150000	1930.00	1930.00	
.1500	180000	2460.00	2460.00	
.1000	230000	5000.00	5000.00	
.0500	323000	4900.00	4900.00	
.0200	490000	12280.00	12280.00	
.0100	640000	13350.00	13350.00	
.0050	840000	14150.00	14150.00	
.0020	1000000	14600.00	14600.00	

EXPECTED ANNUAL DAMAGES

BASE COND-COMPUTED	1721.30	1721.30
BASE COND- INPUT	0.00	-0.00
EXIST SYSTEM-INPUT	696.82	696.82

BASE CONDITION FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	58211	.021	.023	233.27	233.27	
2	194036	.134	.279	569.81	569.81	
3	291054	.062	.050	360.93	360.93	
4	388072	.038	.025	265.87	265.87	
5	582108	.013	.014	173.38	173.38	
6	776188	.007	.010	138.03	138.03	
	BASE COND DAMAGES			1721.30	1721.30	
	EXST SYST DAMAGES			696.82	696.82	

MODIFIED CONDITIONS FLOW-DAMAGE DATA

FREQ	PEAK	SUM	TYPE 1	TYPE
.9990	28800	0.00	0.00	
.9000	35000	.00	.00	
.8000	42000	171.00	171.00	
.7000	50500	361.00	361.00	
.6000	60500	475.00	475.00	
.5000	73000	598.00	598.00	
.4000	90000	855.00	855.00	
.3000	114000	1197.00	1187.00	
.2500	130000	1425.00	1425.00	
.2000	150000	[illegible]	[illegible]	
.1500	180000	[illegible]	[illegible]	
.1000	230000	[illegible]	[illegible]	
.0500	323000	[illegible]	[illegible]	
.0200	490000	[illegible]	[illegible]	
.0100	640000	[illegible]	[illegible]	
.0050	840000	[illegible]	[illegible]	
.0020	1000000	[illegible]	[illegible]	

MODIFIED CONDITIONS FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	33134	.621	.623	32.28	32.28	
2	92488	.134	.279	168.24	168.24	
3	150695	.062	.050	84.24	84.24	
4	237896	.034	.025	121.21	121.21	
5	372066	.013	.018	130.06	130.06	
6	612533	.007	.010	125.58	125.58	
	MODIFIED DAMAGES			661.63	661.63	
	DAMAGE REDUCTION			35.19	35.19	

UNCONTROLLED LOCAL FLOW FLOOD DAMAGES

NO.	FLOW	EXCD FREQ	PROB INT	SUM	TYPE 1	TYPE
1	27735	.621	.623	13.71	13.71	
2	92449	.134	.279	158.13	158.13	
3	138676	.062	.050	72.49	72.49	
4	184898	.034	.025	68.77	68.77	
5	277388	.013	.018	83.48	83.48	
6	369797	.007	.010	102.59	102.59	
	DAMAGES W/ TOTAL CONTROL AT PROJECTS			499.16	499.16	
	REDUCTION POSSIBLE W/ TOTAL CONTROL			197.66	197.66	
	RESIDUAL DAMAGES			162.47	162.47	

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CONTROL POINT 4

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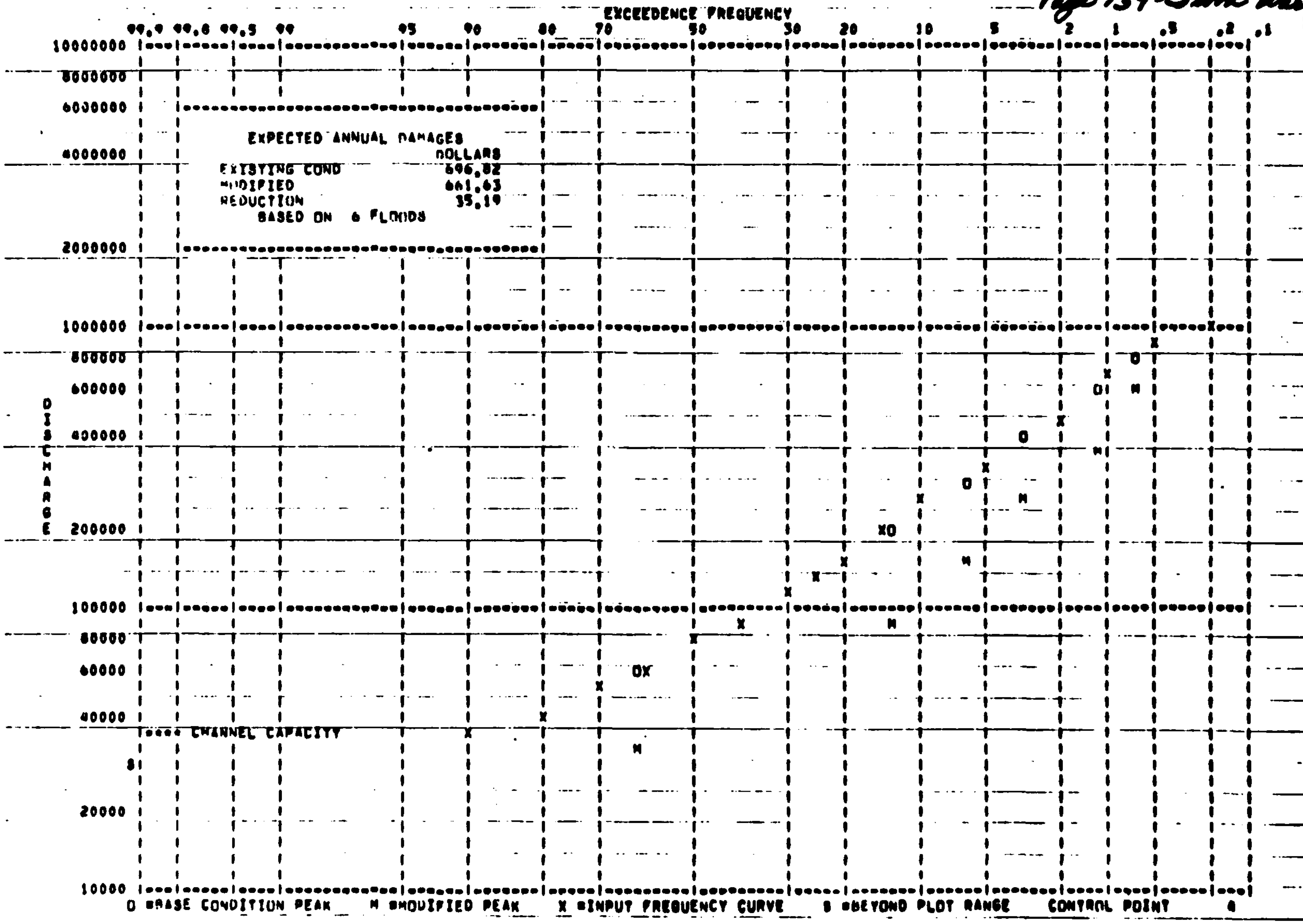

SUMMARY OF SYSTEM'S EXPECTED ANNUAL FLOOD DAMAGES

CONTROL POINT	DAMAGES: BASE (EXIST) CONDITION	DAMAGES: MODIFIED CONDITIONS	DAMAGES: UNCONTROL LOCAL COND	DAMAGE REDUCTION: MODIFIED CONDITIONS	DAMAGE REDUCTION: TOTAL CONTROL AT PROJECTS	DAMAGE REDUCTION: RESIDUAL
4	696.82	661.63	499.16	35.19	197.66	162.47
TOTAL	696.82	661.63	499.16	35.19	197.66	162.47

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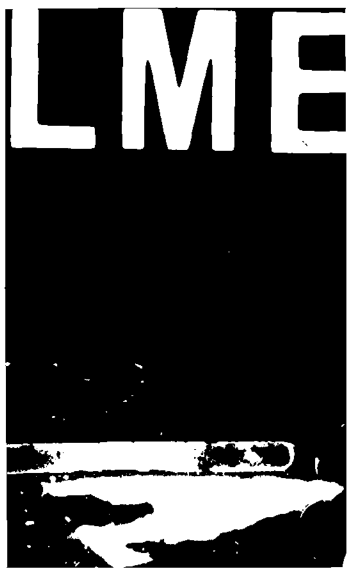
SYSTEM ECONOMIC COST AND PERFORMANCE SUMMARY
(EXCLUSIVE OF EXISTING SYSTEM COSTS)

TOTAL SYSTEM CAPITAL COST	100.00	
TOTAL SYSTEM ANNUAL OPERATING MAINTENANCE, AND REPAIR COST	5.00	
TOTAL SYSTEM ANNUAL COST		10.90
AVERAGE ANNUAL DAMAGES - EXISTING SYSTEM	696.82	
AVERAGE ANNUAL DAMAGES - PROPOSED SYSTEM	661.63	
AVERAGE ANNUAL DAMAGE REDUCTION		35.19
AVERAGE ANNUAL SYSTEM NET DAMAGE REDUCTION BENEFITS		24.29

GPO 690-902/5623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